AT550

Auto Tonometer

Service Manual

Reichert
Ophthalmic Instruments

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Introduction

This document contains the instructions for performance of the Service Software on the AT550 Auto Tonometer, catalog items 13900 and 13901D. The Service Software is provided on a PCMIA card and allows trained technicians to perform the alignment and adjustment of the optical system.

Two versions of Service Software are available for the AT550. Service Software version 1.00 (P/N 13900-953) may only be used with operating software, versions 1.00 and 1.01. Service Software version 1.17 (P/N 13900-954) may only be used with operating software, versions 1.02 thru 1.17. This software is distributed when attending the Reichert Ophthalmic Training Course for Dealers.

The information provided in this document has been prepared for trained service technicians that have attended the training course for ophthalmic instruments given by Reichert Ophthalmic Instruments, A div. of Leica Microsystems, Inc.

Reichert Assistance

The following list contains telephone numbers for the customer service personnel at Reichert Ophthalmic Instruments and the shipping address. If you have questions regarding this document, please contact a technical support representative as indicated below.

Customer Service:
Marie Valentine (716) 686-4582
Sonya Andres (716) 686-4553
Fax: (716) 686-4555

Technical Support:
Ray Halbert (716-686-4584
Fax: (716) 686-4545

Main Switchboard
Receptionist (716) 686-4500

Shipping Address:
Reichert Ophthalmic Instruments
3374 Walden Ave.
Depew, NY 14043

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Warnings & Cautions

Reichert Ophthalmic Instruments is not responsible for the safety and reliability of this instrument when:

- Assembly, disassembly, repair or modification is made by unauthorized dealers or persons.
- Instrument is not used in accordance with its User's Guide.

CAUTION: ANY REPAIR OR SERVICE TO THE AT550 MUST BE PERFORMED BY EXPERIENCED PERSONNEL OR DEALERS WHICH ARE TRAINED BY REICHERT OPHTHALMIC INSTRUMENTS SO THAT CORRECT OPERATION OF THE AT550 IS MAINTAINED.

CAUTION: THIS INSTRUMENT HAS ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) WHICH ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE CORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

CAUTION: MAKE SURE THAT THE VOLTAGE APPLIED TO THE UNIT IS THE SAME AS THE VOLTAGE WHICH IS GIVEN ON THE DATA PLATE NEXT TO THE INPUT CORD RECEPTACLE OR DAMAGE TO THE UNIT MAY OCCUR.

CAUTION: THIS INSTRUMENT MUST BE PLUGGED INTO AN OUTLET WITH AN EARTH GROUND WHICH IS CONNECTED TO THE RECEPTACLE OR DAMAGE TO THE UNIT MAY OCCUR. DO NOT DISABLE OR REMOVE THE GROUND PIN.

CAUTION: USE ONLY A 13717 CALIBRATED RUBBER EYE FIXTURE WHICH HAS BEEN VERIFIED FOR ACCURACY AT THE REICHERT FACTORY WITHIN THE LAST 6 MONTHS OR INCORRECT CALIBRATION MAY RESULT.

CAUTION: DO NOT USE SOLVENTS OR STRONG CLEANING SOLUTIONS ON ANY PART OF THIS INSTRUMENT OR DAMAGE TO THE UNIT MAY OCCUR.

CAUTION: USE OF ALCOHOL ON THE LIQUID CRYSTAL DISPLAY (LCD) MAY CAUSE DAMAGE TO THE DISPLAY.

WARNING: THIS INSTRUMENT IS NOT SUITABLE FOR USE IN THE PRESENCE OF FLAMMABLE ANESTHETIC MIXTURES, SUCH AS OXYGEN OR NITROUS OXIDE.

Theory of Operation

AT550 Introduction

The AT550 is an advanced electronic tonometer which acquires IOP (Intraocular Pressure) data from the eye and also contains an innovative automated alignment system which quickly aligns itself to the patient during the measurement process.

Special Features of the AT550

The AT550 has special features which are not available on other tonometers. The AT550 features are: it can be serviced in the field, it has a port for installing software upgrades, and it utilizes an auto alignment system. Additional features contained in this instrument are an automated L/R Detector, and a Travel Lock Assembly. A description of the special features of the AT550 are as follows:

Field Service

The calibration data of the AT550 is installed into a single independent assembly (referred to as the tonometer head assembly or “toolbox”) and can be replaced at a remote location, not requiring the complete instrument to be returned to the factory. The optical head assembly is fully calibrated before it is sent from the factory.

Software Installation

The operating system was designed to accept upgrade options without making it necessary to return the instrument to the factory. The access port for this option is placed behind the printer door and accepts a PC Card that is pre-programmed with the applicable upgrades.

Auto Alignment System

Our patented "hands-free" auto-alignment technology in this instrument removes the necessity to adjust any joystick or chin rest. The patient simply leans against the appropriate side of the forehead rest, views a green fixation target, and then is ready for the operator to initiate the measurement process. The AT550 then aligns itself in front of the eye and automatically acquires the appropriate data.

Left / Right Detector

Each instrument contains a Left / Right detector that automatically detects which eye the instrument is measuring. If the instrument can not select the appropriate eye, a menu is displayed requesting that the operator select the appropriate side.

Travel Lock Assembly

A travel lock assembly is provided within the instrument to secure the positioning system during transportation. This assembly ensures that during transportation, the operational integrity of the instrument is maintained.

Positioning System Operation

The new AT550 optimizes the alignment of the patient to the optical system without the use of a joystick or the necessity of a chinrest. The patient only has to set their head against the left or right side of the headrest. The measurement process then automatically aligns and acquires the eye data quickly and accurately, as requested by the operator. During the entire measurement process, the alignment system verifies the correct position of the patient to ensure that correct positioning is maintained for accurate measurement data. Refer to Figure OP-1 for a drawing of the Positioning System Block Diagram.

Details of the Alignment System

The auto-alignment system of the auto-tonometer uses two positioning LEDs (wavelength = 875 nm) and two receiving cameras (plus other minor components) to align the system to the patient.

When a measurement is requested by an input from the operator (button push) the Motor Control Board applies power to the right Position LED. The LED emits light toward the eye. Some of the emitted light reaches the eye and is reflected off the cornea and is sent to the 1st Surface Mirror on the opposite side. This light is then reflected off of the mirror and continues on through the IR Filter, Position Lens, Spacer Lens and finally to the Position LED Camera.

The Position LED Camera receives the light source data and converts it to electronic data. This converted data is sent to the Video Circuit Board, Control Board, I/O Board, and Motor Board where it is processed using a proprietary processing technique (a process for which patents have been issued) to provide precise alignment of the system to the eye.

After the right side Position LED Camera receives its data the left side Position LED and camera alternately turns on and acquires its data. The right and left side Position LED's are alternately activated to allow for three dimensional positioning. After data is acquired, from the Video Circuit Board, the positioning system adjusts the optical head assembly for best focus. This alignment process continuously updates throughout the measurement process.

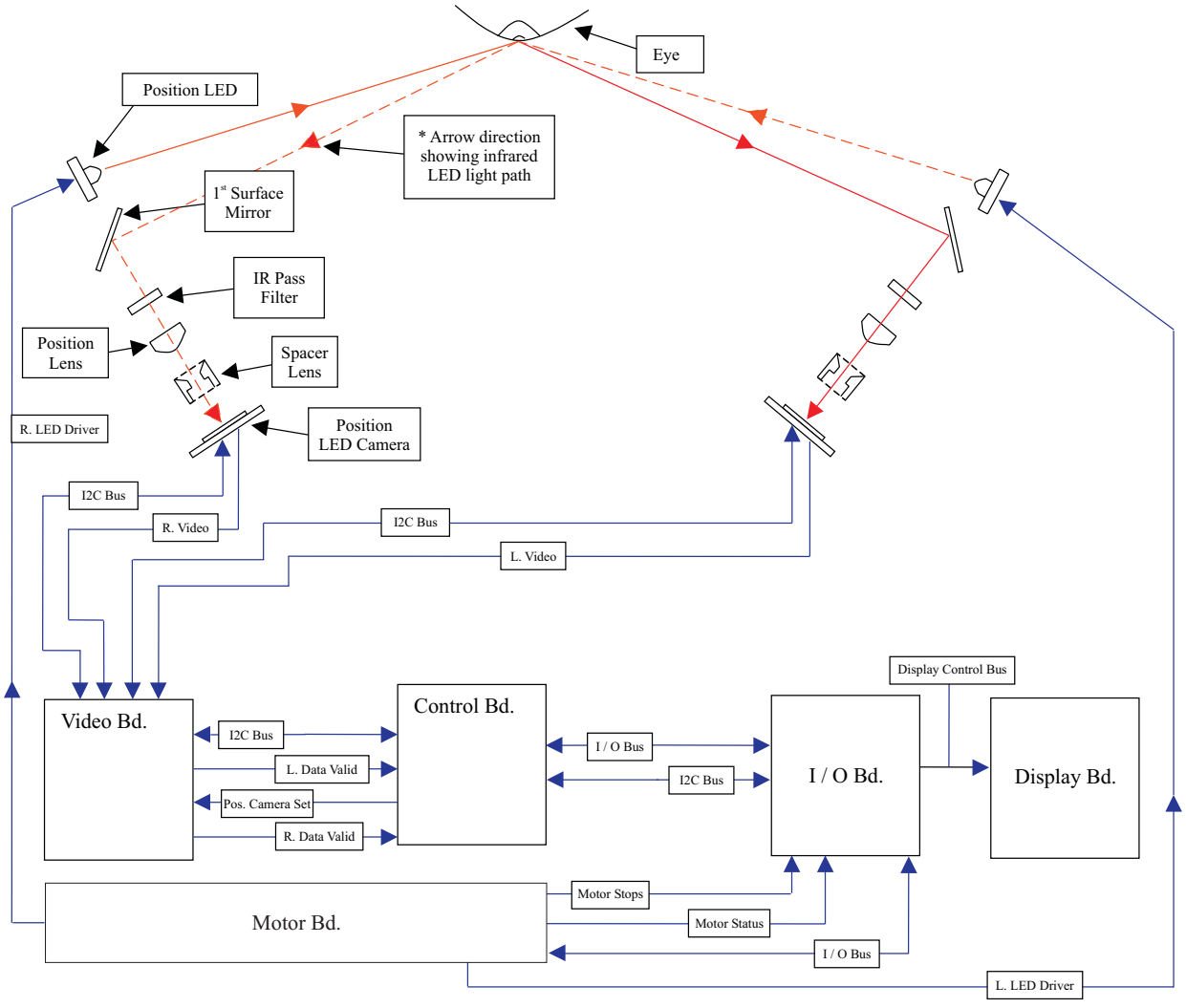

Figure OP-1. Alignment System

Theory of Operation (Continued)

Air Puff System

The air puff system produces a small puff of ambient air out of the nozzle of the air tube when the patient is fully aligned in front of the instrument. The puff of air is directed at the center of the cornea which causes the cornea to applanate. The air puff system consists of a piston within a stainless steel cylinder, a solenoid drive for the piston and a "nosepiece" assembly that contains the air tube.
The piston and solenoid provide the force to push the air out of the air tube. The nosepiece assembly combines the air puff, target illuminator, pressure monitoring, applanation detection and the proximity detection functions together to enable a closed loop system.

When the patient is positioned correctly in front of the air tube and observes the green target, the piston is activated. After the air is delivered to the cornea and the cornea has applinated, light from the emitter diode is sensed by the detector. When the detector has reached its highest output signal (applanation of the eye), the solenoid drive to the piston immediately stops and air pressure quickly ramps down. When the retaining spring attached to the piston overcomes the ramp down pressure, the piston is reset to its original position. The internal manifold inside the nosepiece assembly monitors the pressure just behind the air delivery tube. The forced air from the tube is proportional to the pressure inside the manifold. This pressure is constantly monitored and the pressure at the time of applanation is detected and recorded. This pressure is a measure of the force required to applanate the cornea and is displayed as the IOP reading.

Applanation System.

The applanation system consists of an infra red emitter (875 nm) and detector placed so that the energy from the emitter is directed obliquely toward the cornea. The detector is placed tangentally from the emitter so that light reflected from the flattened cornea will be directed to the detector. An undisturbed cornea (non-applanated) will direct very little amount of infrared light toward the detector. As the curvature of the cornea starts to applanate by the air pulse, the infrared light increases to the detector until a maximum level is detected at the exact instant of flattening (e.g., applanation). This is followed by a rapid decrease in the amount of infrared light detected as the cornea becomes slightly concave. At the exact instant of applanation, the pressure is recorded. This pressure is then converted directly to an IOP reading and is displayed on the LCD screen.

Proximity Detector

The proximity detector is a sensor which is attached to the end of the air tube. This circuit prohibits the air tube from contacting the eye.

This circuit contains an oscillator and its associated circuitry to detect external capacitance (the human body or an eye which is within approximately 1/4" of the cornea) near the airtube. This circuit contains a copper ring and two semi-circular rings surrounding the end of the air tube. The capacitance between these rings will change which will then disable the motor drive circuits when it detects thre external capacitance .

Target Illuminator

The target illuminator is a visible target which the patient utilizes to align their eye to the instrument. This target is located at the back of the nosepiece assembly at the opposing endof the air tube. During alignment of the patient to the instrument, the patient initially finds the green target, then moves forward to place their head against the headrest. Once against the headrest the instrument quickly finds the eye and takes a measurement.

Touch Sensor

This instrument contains a touch sensor which will stop the motion of the alignment system if activated. If someone (e.g., patient) touches the inside edge of the touch plate (grey plate which surrounds the nosepiece cover) the message "Touch Sensor Activated" will appear and the alignment system will stop its movement. After the alignment system stops, it will then retract to the home position.

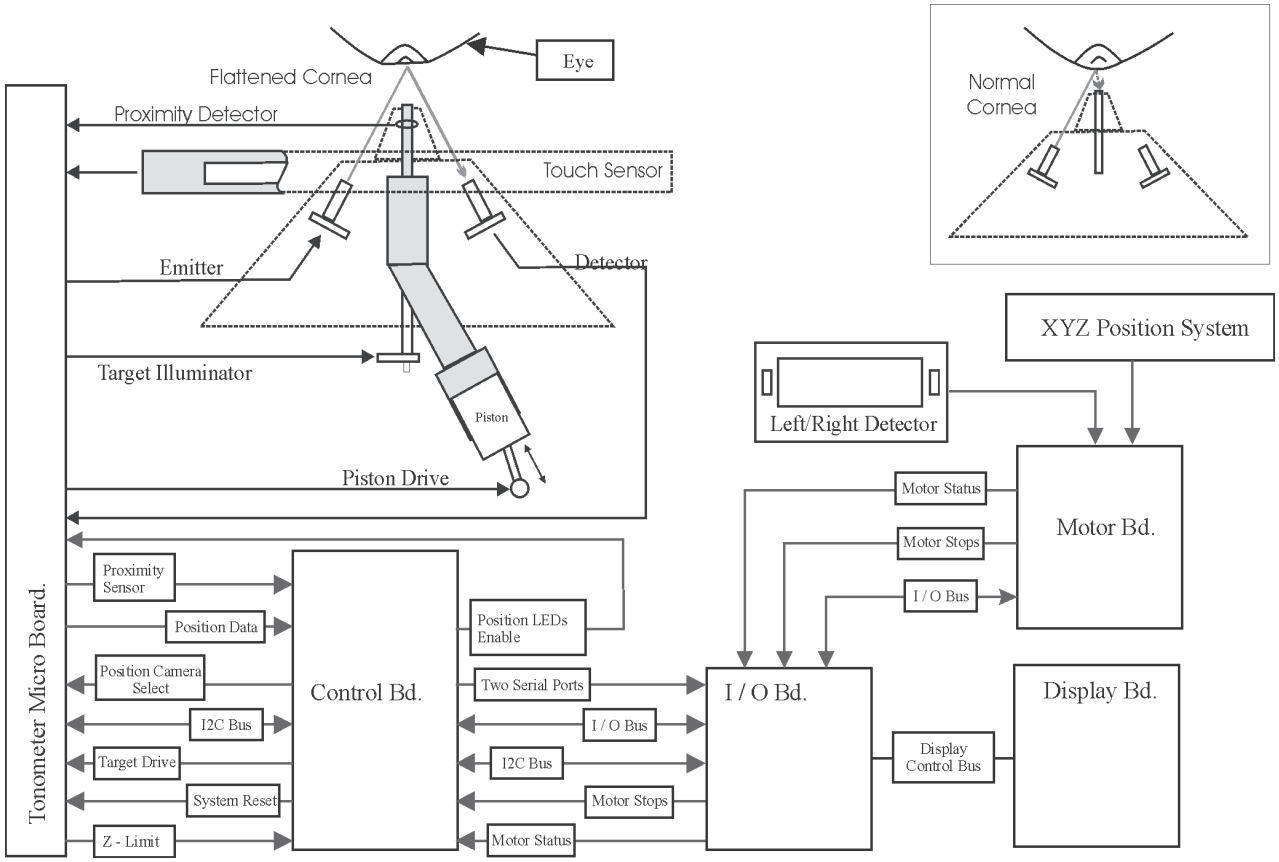

Figure OP-2. Measurement System

Troubleshooting

The following list provides suggestions when a fault condition exists.

Note: Reference to a Harness Connection List is given in Appendix B.

Error Codes

This instrument is designed to display error codes when a malfunction has occurred. These error codes will aid the technician to isolate the malfunction. Probable causes are listed in sequence of probability (first probable cause listed is the most likely cause or the easiest to test). The following list provides the error codes and its definition.

Note: When Error Codes are displayed it is suggested that the instrument be "re-booted" (remove input power and then re-apply input power) as the Error Code may be the result of a computer "glitch." If after input power is reset and the unit continues to display the Error Code, continue to the Error Code Table and check the probable cause.

Note: To provide concise information on specific parts, assemblies, and/or connector designators (e.g., P1) they are indicated and followed by the associated Parts Manual figure and item number (e.g., Fig. 7, 27) .

Note: Error Codes caused by components within the Optical Head Assembly (Fig.7, 7) require replacement of the complete Optical Head Assembly and will only reference the replacement assembly. However, if an error code can be caused by a disconnected connector within the assembly, reference to that connector is also given.

Error Code Table

Code#	Definition	Probable Cause
1	CPU diagnostic failed	Defective Control Board (Fig.7,31)
2	RAM diagnostic failed	Defective Control Board (Fig.7,31)
3	PROM diagnostic failed	Defective Control Board (Fig.7,31)
4	NVRAM diagnostic failed	Defective Control Board (Fig.7,31)
5	EEPROM diagnostic failed	Defective Optical Head Assy (Fig.7,7)
6	X motor failed	J1 (Fig.7, 16) Disc'd
		J8, J10, or J12 (Fig.7, 16) Disc'd
		X,Y,Z Motor Connectors Interchanged
		U5, U6, U7 (Fig.7,16) FPGA Chip Not Seated Properly
		Defective Motor Data Cable Harness (Fig.7,21)
		Defective Motor Board (Fig.7,16)
		Defective Power I/O Board (Fig.7,27)
7	Y motor failed	Same as Error Code 6
8	Z motor failed	Same as Error Code 6
9	System failed to home motors	Same as "Disengage Travel Lock" in this section
10	Travel lock is engaged	Same as "Disengage Travel Lock" in this section
11	System failed to park motors	Same as "Disengage Travel Lock" in this section
12	Stray light has been detected	Not used in this instrument
13	Positioning motor error	J1 (Fig.7, 16) Disc'd
		Same as Error Code 7
14	Left VVL camera error	J2 (Fig.7, 31) Disc'd
		Software incompatibility issue.
		J1 (Fig.7, 7) Disc'd
		J8 (Fig.7, 7) Disc'd
		Defective Optical Head Assembly

- Continued on next page -

Troubleshooting (Continued)

Error Code Table (Continued)

Code#	Definition	Probable Cause
15	Right VVL camera error	J2 (Fig.7, 31) Disc'd Software incompatibility issue. J2 (Fig.7, 7) Disc'd J8 (Fig.7, 7) Disc'd Defective Optical Head Assembly
16	Undefined	Not used in this instrument
17	Tonometer Subsystem Error	Defective Tonometer Circuit Board, replace the Optical Head Assembly
18	Positioning Subsystem Error	J2 (Fig.7, 31) Disc'd Software incompatibility issue. J1 (Fig.7, 7) Disc'd J2 (Fig.7, 7) Disc'd J8 (Fig.7, 7) Disc'd Defective Optical Head Assembly
19	Undefined	Not used in this instrument
20	DAC error	Defective Tonometer Circuit Board, replace the Optical Head Assembly
21	I^2C bus error	J2 (Fig.7, 31) Disc'd J7 (Fig.7, 7) Disc'd J8 (Fig.7, 7) Disc'd

Disc'd = Disconnected or intermittent connections. Check crimp joints and continuity from pin to pin.

Quick Reference Guide
Fig.7,7 = 13900-851 Optical Head Assy
Fig.7,16 = 13960-924 Motor Board Assy
Fig.7,27 = 13960-925 Power I/O Board
Fig.7,31 = 13900-921 Control Board Assy

Troubleshooting (Continued)

Miscellaneous System Errors

The information in this section will aid the technician to isolate the malfunction. Probable causes are listed in sequence of probability (first probable cause listed is the most likely cause or the easiest to test). The following list provides some known System Errors that can occur. This list cannot include all the possible errors for this instrument, however, continuous information will be added at each revision to this manual as it is revised.

Note: To provide concise information on specific parts, assemblies, and/or connector designators (e.g., P1) are indicated and followed by the associated Parts Manual figure and item number (e.g., Fig. 5, 27) .

Note: Reference to the Harness Connection List is given in Appendix B.

Miscellaneous System Errors

Definition	Probable Cause	Solution
Screen Blank	Unit in Sleep Mode.	Depress any button.
	No power applied to unit.	Apply input power.
	Reset Button (Fig.7,28) stuck.	Release stuck button.
	Contrast knob turned down.	Adjust contrast knob.
	Fuse(s) Blown.	Replace blown fuse(s) (Fig.4,30) or fuse on Power I/O Board (Fig.7,27).
	Transformer fused winding opened.	Replace Transformer (Fig.4,32).
	J4 (Fig.7,16) Disc'd.	Attach connector.
	J13 (Fig.7,27) Disc'd.	Attach connector.
	Does not exit Sleep Mode.	Refer to LCD Brightness Adjustment in the Calibration section.
	Single line on screen.	Replace Power I/O Board (Fig.7,27).
Screen Bright with no data showing	Cables to LCD Screen not properly connected.	Check connections and re-attach if necessary.
	J3 (Fig.7,7) Disc'd.	Attach connector.
Disengage Travel Lock Showing.....	Travel Lock Engaged.	Disengage Travel Lock.
	J2, J8, J10, J12 (Fig.7, 16) Disc'd.	Attach connector.
	R15 (Fig.7,16) Not adjusted correctly.	Refer to Position System Motor Current Adjustment in the Calibration section.
	Sensor Flags for the XYZ Home Position.	Align sensor flags to sensors / sensor.
Too Close Message Showing	Eyelashes touching the end of the air-tube.	Have the patient open their eye wide.
	Touch sensor contaminated.	Clean touch sensor (end of the air-tube) with an alcohol pad.
	Touch sensor circuit defective.	Replace Proximity Board (13900-931).
Position Patient Message Showing	Patient not looking at green fixation LED.	Instruct pateint to look for fixation LED, then move in toward headrest.
	Position LED's Disc'd.	Attach connector / check connections.
	Blocked alignment path.	Clear alignment path / clean widows.
Does Not Find the Eye	Moves straight out , goes out then straight back (can't find anything).	Ensure light path from VVL diodes t cameras is unobstructed. Check connection to diodes/cameras. Replace diode and/or camera.

- Continued on next page -

Troubleshooting (Continued)

Miscellaneous System Errors (Continued)

Definition	Probable Cause	Solution
Does Not Find ... (Continued)	External light confusing positioning system.	Isolate sources of external light (incandescent and/or infrared) and remove light source.
Finds one eye not the other Infrared interference	Light interference on measuring side	Remove interference (infrared light source).
Tries three times to find the eye Proximity Detector	Proximity detector is activated.	Eliminate touching end of nosepiece. Replace detector circuit.
Will Not Take a Reading	Patient not holding still. Patient's eye too far from Patient Window. Patient not focusing on target (eye moving around). Patient has dry eye.	Encourage patient to remain still. Have patient move toward nosepiece. Have patient look only at target. Have patient blink eyes
Asterisk Readings	Unit needs reboot of hardware. Dirty position alignment windows. Unit out of alignment. Loose lenses in the VVL lens cell	Unplug unit, wait 10 seconds the apply input power. Clean the positioning windows as indicated in the Cleaning section. Perform the Calibration procedure as indicated in this manual. Install a new lens cell.
No Applanation Readings	J7,J8 (Fig.7,7) Disc'd or reversed. Unit much out of alignment. Piston not working.	Attach connector. Perform the Calibration procedure as indicated in this manual. Check connection at J13 (Fig.7,7). Replace defective piston/solenoid.
Printer Not Printing	Printer out of paper. Cables not connected. Printer not printing characters	Replace paper with P/N 12441. Re-attach J10 and/or J12 (Fig.7,27). Replace print head (P/N 13963-401).

Disc'd = Disconnected or intermittent connections. Check crimp joints and continuity from pin to pin.

Quick Reference Guide
Fig.7,7 = 13900-851 Optical Head Assy
Fig.7,16 = 13960-924 Motor Board Assy
Fig.7,27 = 13960-925 Power I/O Board
Fig.7,31 = 13900-921 Control Board Assy

Testing

Introduction

The following section provides testing procedures and troubleshooting guides that give helpful suggestions when incorrect operation of the AT550 occurs.

A list of general specifications (e.g., size, weight, voltage requirements, etc.) for this instrument is given in Appendix A.

A list of software revisions for this instrument is included in Appendix C.

CAUTION: ANY REPAIR OR SERVICE TO THE AT550 MUST BE PERFORMED BY EXPERIENCED PERSONNEL OR DEALERS THAT ARE TRAINED BY REICHERT OPHTHALMIC INSTRUMENTS SO THAT CORRECT MEASUREMENT OF THE AT550 IS MAINTAINED.

CAUTION: THE INTERNAL CIRCUITS OF THIS INSTRUMENT HAVE ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) AND ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE CORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

Note: Before internal troubleshooting can occur, the top and side covers of the instrument must be removed. Refer to the Disassembly section of this manual for the details.

Note: The Optical Head Assembly has a warranty seal installed over an attaching screw that secures the optical head cover. Removing the seal from this screw voids warranty, unless pre-authorized from an Reichert Customer Service Representative.

Special Tools & Equipment

The following special tools and equipment are necessary to perform the steps in this section.

Digital Voltmeter (-50 to +50 VDC)
Digital Oscilloscope (Digital Real Time, 1GHz)

LCD Brightness Adjustment

This procedure details the adjustment of the brightness for the LCD backlight. This adjustment is located on the Power Input / Output Board (Fig.7,27) (citcuit board on bottom of unit). Refer to Table 1 for the voltages required at TP9. To determine which LCD you have and are replacing, refer to Figures 1 and 2.

1. Apply the +probe of a digital voltmeter to TP9 on the bottom circuit board and the –probe to pin 5 of the RS232 connector located next to the input power connector.
2. Adjust R1 until the voltage at TP9 is set as indicated in Table 1 while referencing the correct LCD Assembly.
3. Apply one small drop of enamel paint (e.g., nail polish) to the top of R1 so that it will not be moved accidently.

LCD Contrast Adjustment

This procedure details the adjustment of the LCD contrast control on the Power Input / Output Board. Refer to Table 1 for the voltages required at the test points (TP). To determine which LCD you have or are replacing, refer to Figures 1 and 2.

1. Adjust the external contrast knob near the RS232 connector to mid-range.
2. Apply the +probe of a digital voltmeter to TP2 on the bottom circuit board and the -probe to pin 5 of the RS232 connector located next to the input power connector.
3. Adjust R20 until the voltage at TP2 is set as indicated in Table 1 while referencing the correct LCD Assembly.
4. Apply one small drop of enamel paint (e.g., nail polish) to the top of R20 so that it will not be moved accidently.

LCD Part Number	TP9 (R1)	TP2 (R20)
13920-947	0.75 VDC	-20.5, ±0.1 VDC
13960-945	0.85 VDC	-19.6, ±0.1 VDC
13960-966	0.85 VDC	-18.0, ±0.2 VDC

Table 1. Test Point Voltages

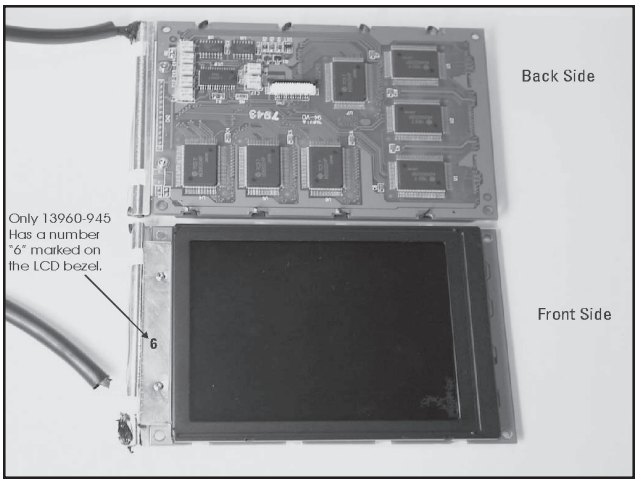

Figure CT-14. LCD P/N 13920-947 or 13960-945

Note: The 13960-945 has a "6" marked on the bezel, however, the 13920-947 does not have a "6" marked on the bezel. The 13920-947 and the 13960-945 circuit boards are the same.

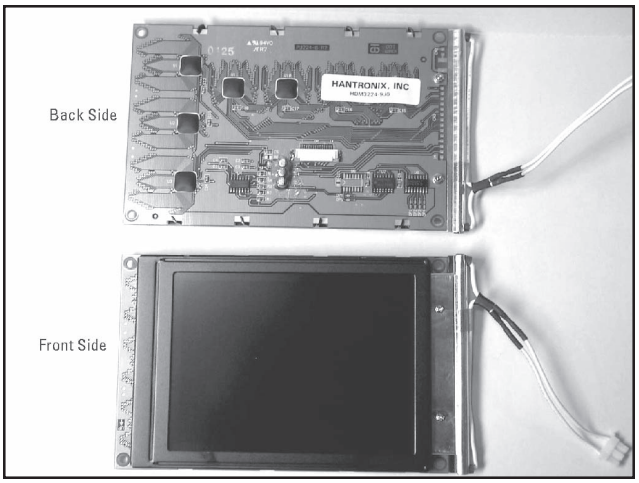

Figure CT-15. LCD P/N 13960-966

Note: The 13960-966 has a different circuit board than that of the 13920-947 and the 13960-945.

Test Point Voltages

The following information regarding the test points that are located on the circuit boards of this instrument are given as a guide to verify the correct operation of the unit. If special operating conditions are required to observe the references given, effort will be given to provide the necessary information with the appropriate references.

Power Input / Output Circuit Board (Assy 13960-925, Schematic 13960-915) Refer to Figures TT-1 & TT-2.

Test Points
TP1 = Test Point 1, +6 Volts peak (half wave) at 50 KHz.
TP2 = Test Point 2, –20.5 VDC (note: LCD screen must be ON). Refer to the Calibration section for voltage level adjustment.
TP9 = Test Point 9, +750 mVDC (note: LCD screen must be ON). Refer to the Calibration section for voltage level adjustment.
TP10 = Test Point 10, Signal Ground (0 VDC)
TP11 = Test Point 11, Vcc Ground (0 VDC)

Note: Pin 5 of the RS232 serial port is also Vcc Ground (0 VDC)

J4 Connector Header
Pin 1 = Vcc Ground (0 VDC)
Pin 7 = –8.0 VDC
Pin 8 = +8.8 VDC
Pin 9 = +8.8 VDC

Misc. Test Points
C60(+) = +15 VDC
CR10(–) = +18 VDC)
CR11(+) = –18 VDC)
CR12(–) = +Vcc (+5.0 VDC)
Y1 (pin closest to C9) = 8.0 MHZ Sinusoid
Voltage at F1 (main fuse on ckt bd) = 14 to 16 VDC

Main Control Circuit Board (Assy 13900-921, Schematic 13900-911) Refer to Figures TT-3 & TT-4.

Oscillator Outputs
Y1 = 16.0 MHz (approx 5.5 Vp-p Sinusoid)
Y2 = 3.69 MHz (approx 5.5 Vp-p Sinusoid)
Y3 = 32.8 KHz (approx 1.7 Vp-p Sinusoid)

J1 Connector
Pin B1 = Vcc Ground (0 VDC)
Pin B32 = +5.0 VDC, +Vcc

P1 Connector Header Jumpers
Pin 5 + 6, Watch Dog Disable (used for testing). Should not short pins 5+6 during normal operation.
(Jumper in = Disable, Jumper out = Enable)

Misc. Test Points
CR1 = Red/Green. Green = normal operation, Red = hardware failure or reset.

Testing (Continued)

Motor Control Circuit Board (Assy 13900-945, Schematic 13960-914) Refer to Figures TT-5 & TT-6.

Test Points
TP1 = Test Point 1, 2.4 KHz Square Wave @ +5.0 VDC p-p, Motor Clock
TP2 = Test Point 2, 2.4 KHz Square Wave @ +3.6 VDC p-p, X-Axis Motor Clock
TP3 = Test Point 3, 2.4 KHz Square Wave @ +3.6 VDC p-p, Y-Axis Motor Clock
TP4 = Test Point 4, 2.4 KHz Square Wave @ +3.6 VDC p-p, Z-Axis Motor Clock
TP5 = Test Point 5, Positioning System Drive Current Sense Voltage
TP6 = Test Point 6, R Motor Drive Current Sense Voltage
TP7 = Test Point 7, X Axis Motor Drive 1 Signal
TP8 = Test Point 8, X Axis Motor Drive 2 Signal
TP9 = Test Point 9, Y Axis Motor Drive 1 Signal
TP10 = Test Point 10, Y Axis Motor Drive 2 Signal
TP11 = Test Point 11, Z Axis Motor Drive 1 Signal
TP12 = Test Point 12, Z Axis Motor Drive 2 Signal
TP13 = Test Point 13, Vcc Ground

J4 Connector, Power Input
Pin 1 = +5.0 VDC, +Vcc Supply Voltage
Pin 2 = +5.0 VDC, +Vcc Supply Voltage
Pin 3 = +14.0 to +16.0 VDC Motor Voltage
Pin 4 = +14.0 to +16.0 VDC Motor Voltage
Pin 5 = Ground
Pin 6 = Ground

J13 Connector, Left / Right Detector Circuit
Pin 1 = Right Eye Detect, +5 VDC When ON, 0 VDC When OFF
Pin 2 = Left Eye Detect, +5 VDC When ON, 0 VDC When OFF
Pin 3 = +5 VDC Vcc
Pin 4 = Vcc Ground

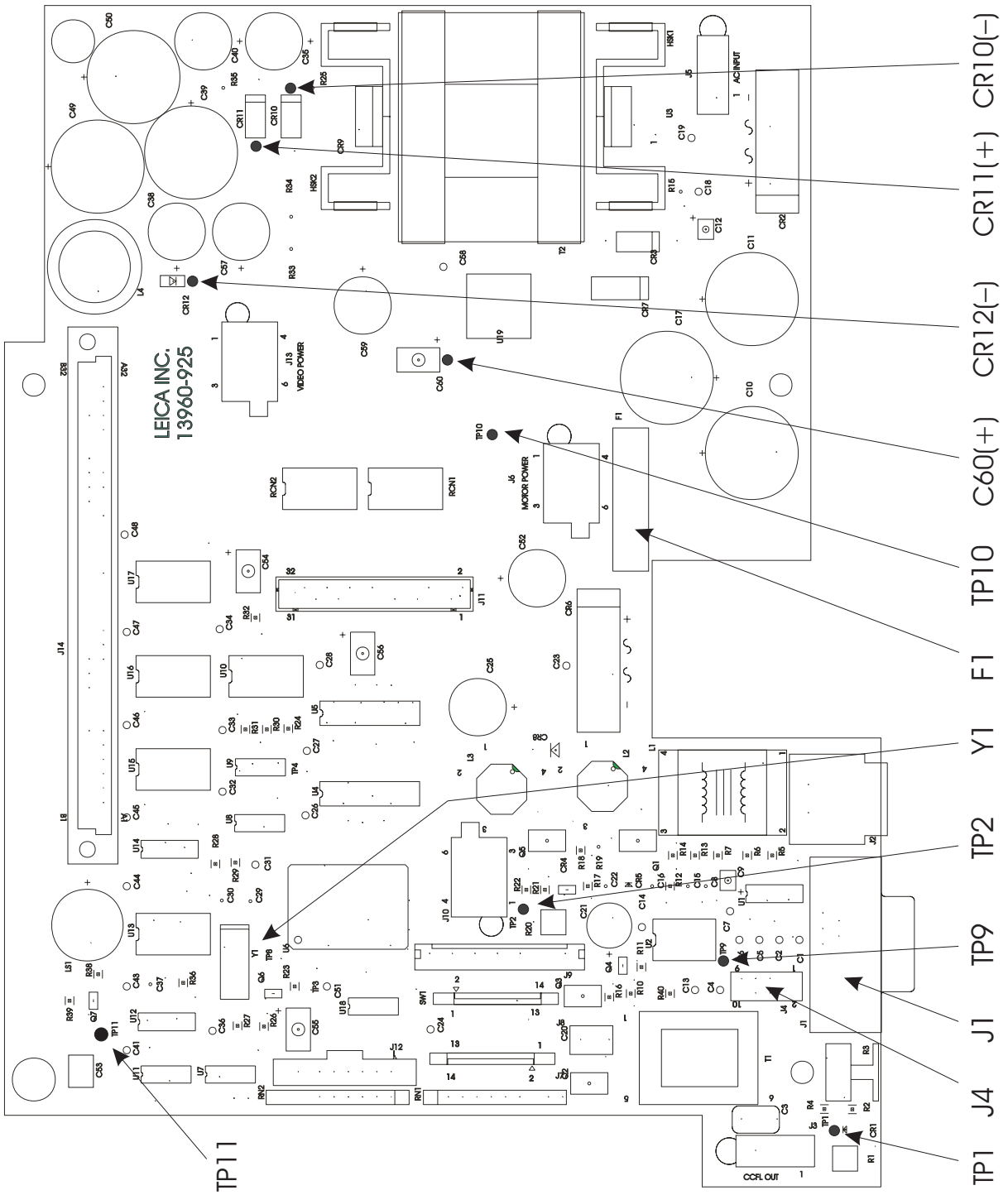

Figure TT-3, Power Input / Output Circuit Board Layout

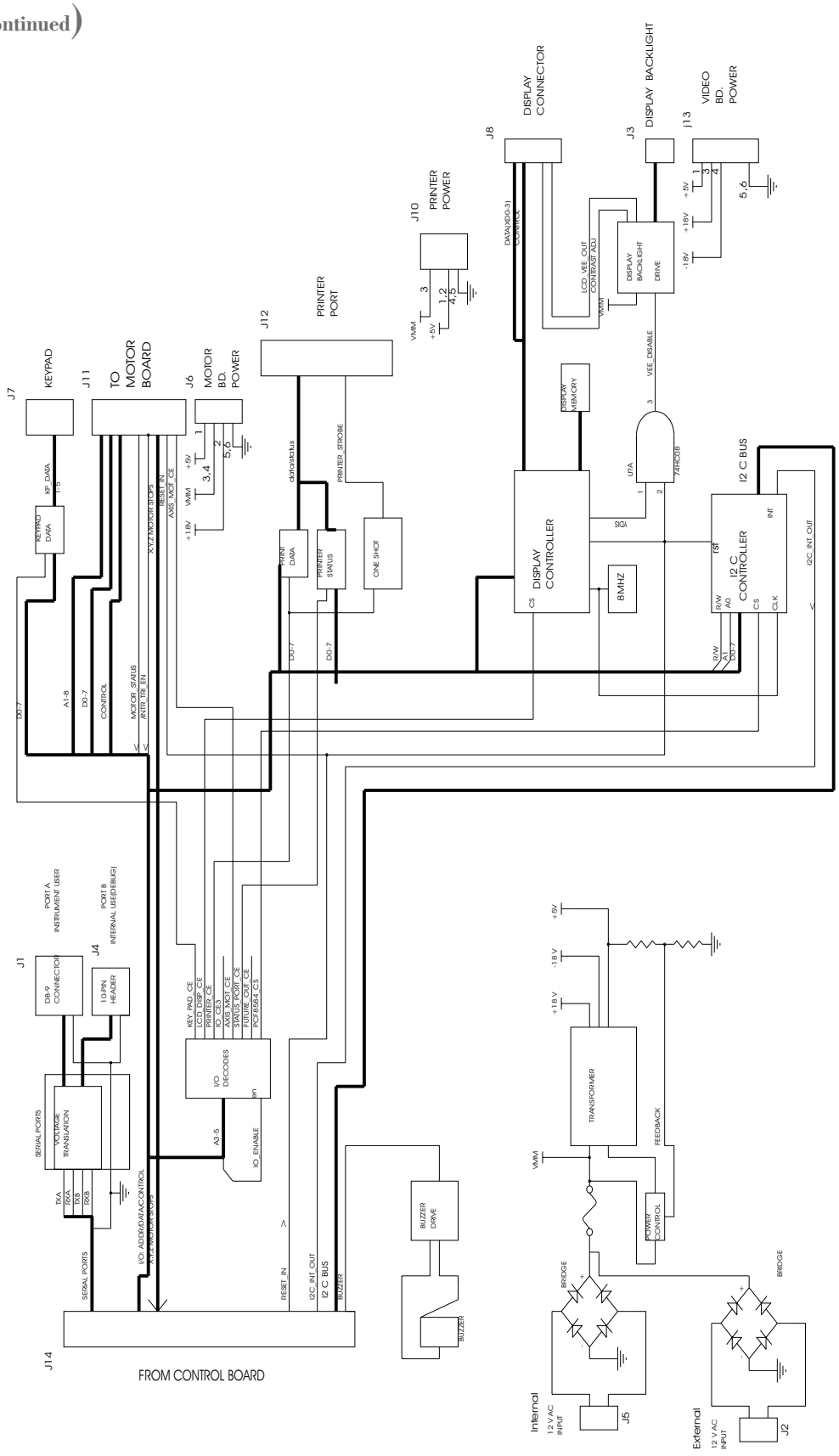

Figure TT-4, Power Input / Output Block Diagram

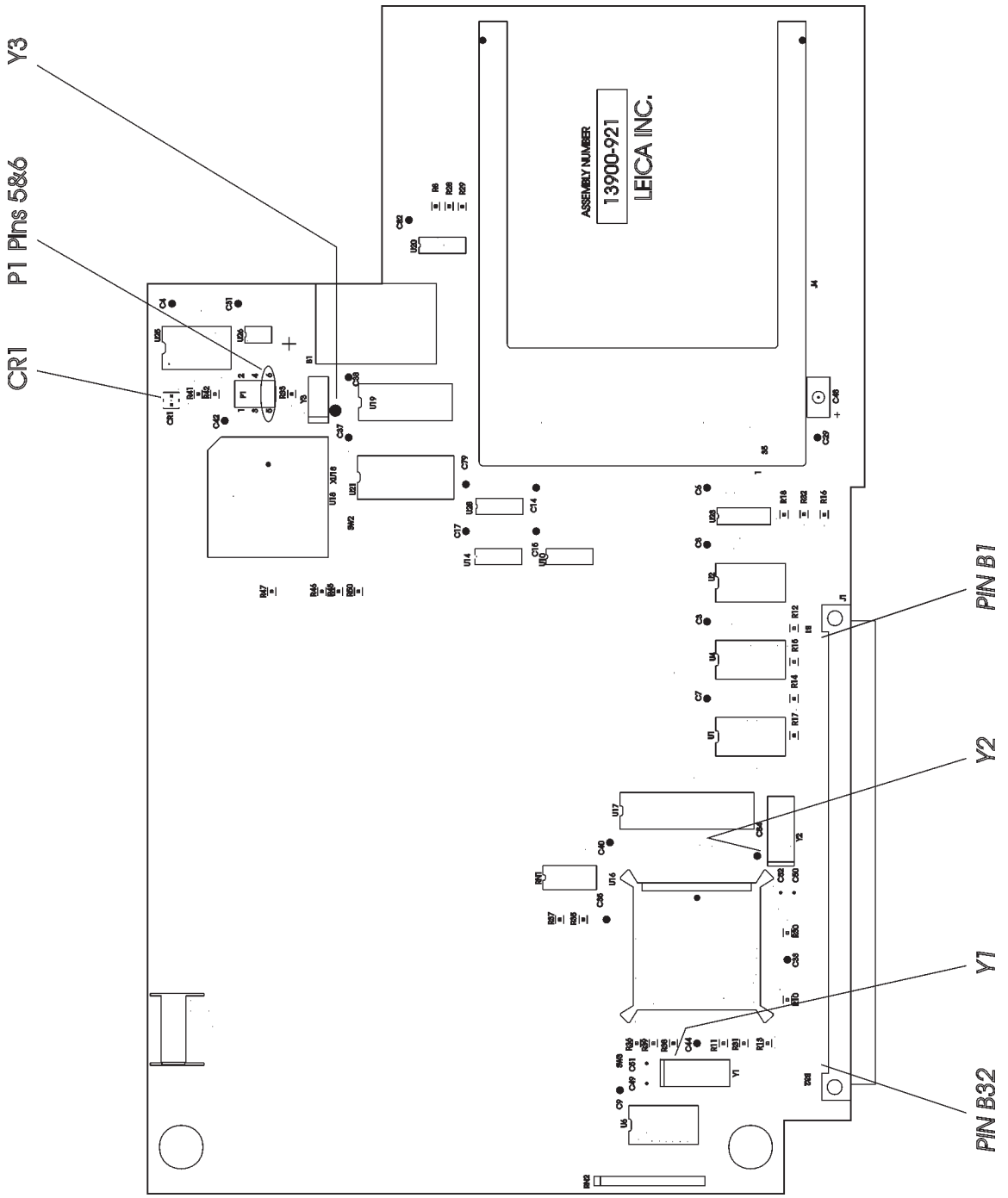

Figure TT-5, Main Control Circuit Board Layout

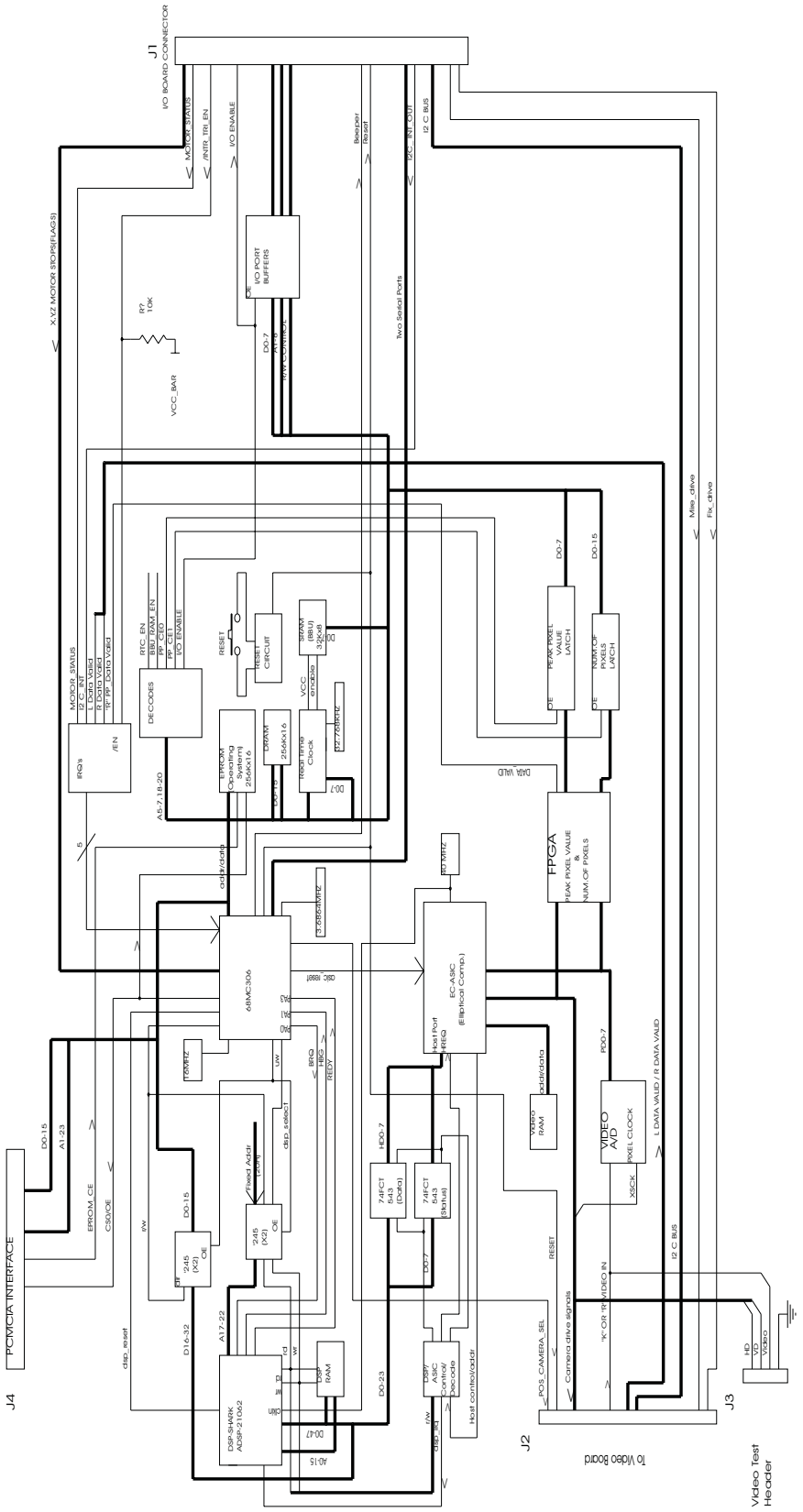

Figure TT-6, Main Control Block Diagram

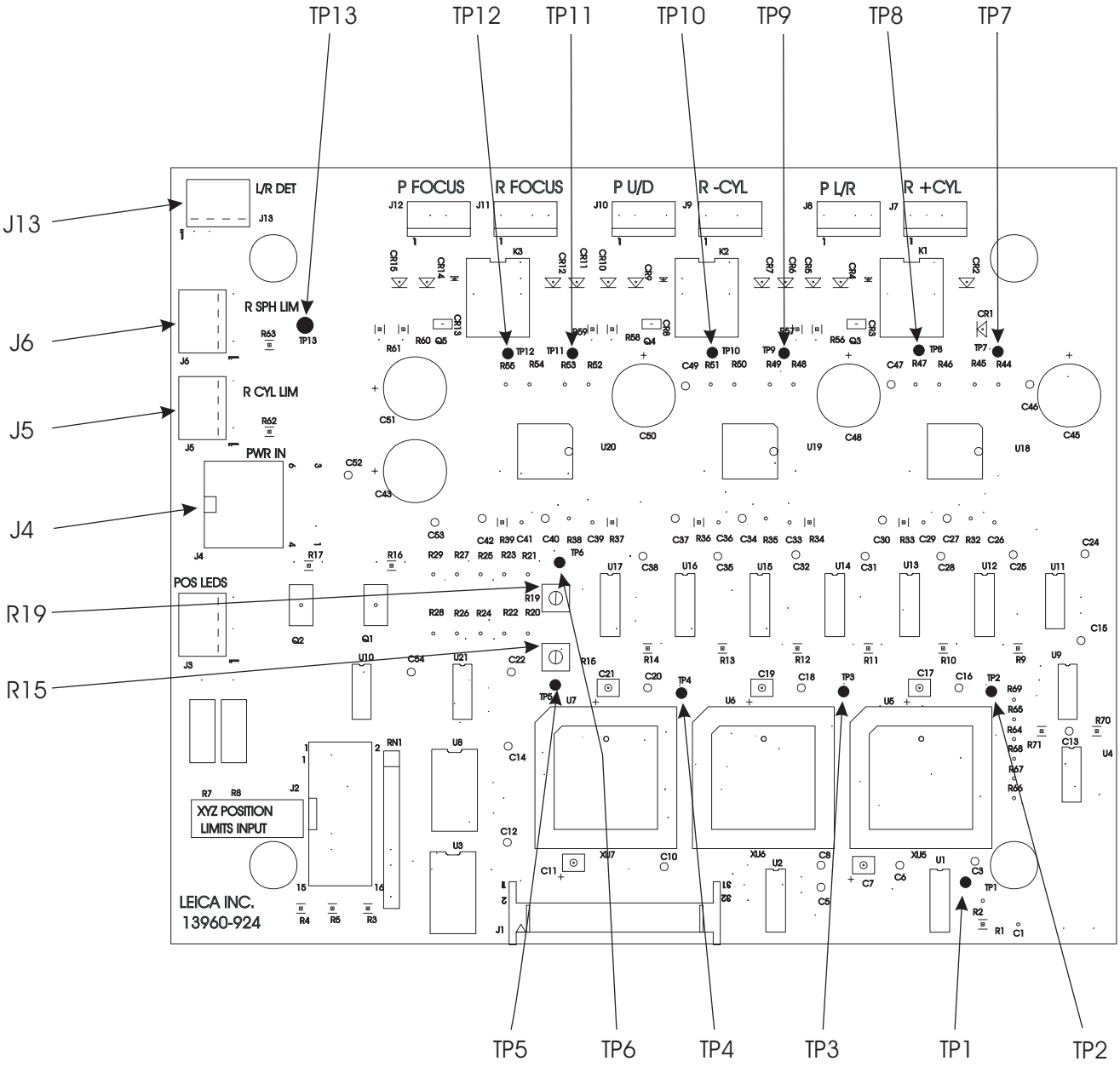

Figure TT-7, Motor Control Circuit Board Layout

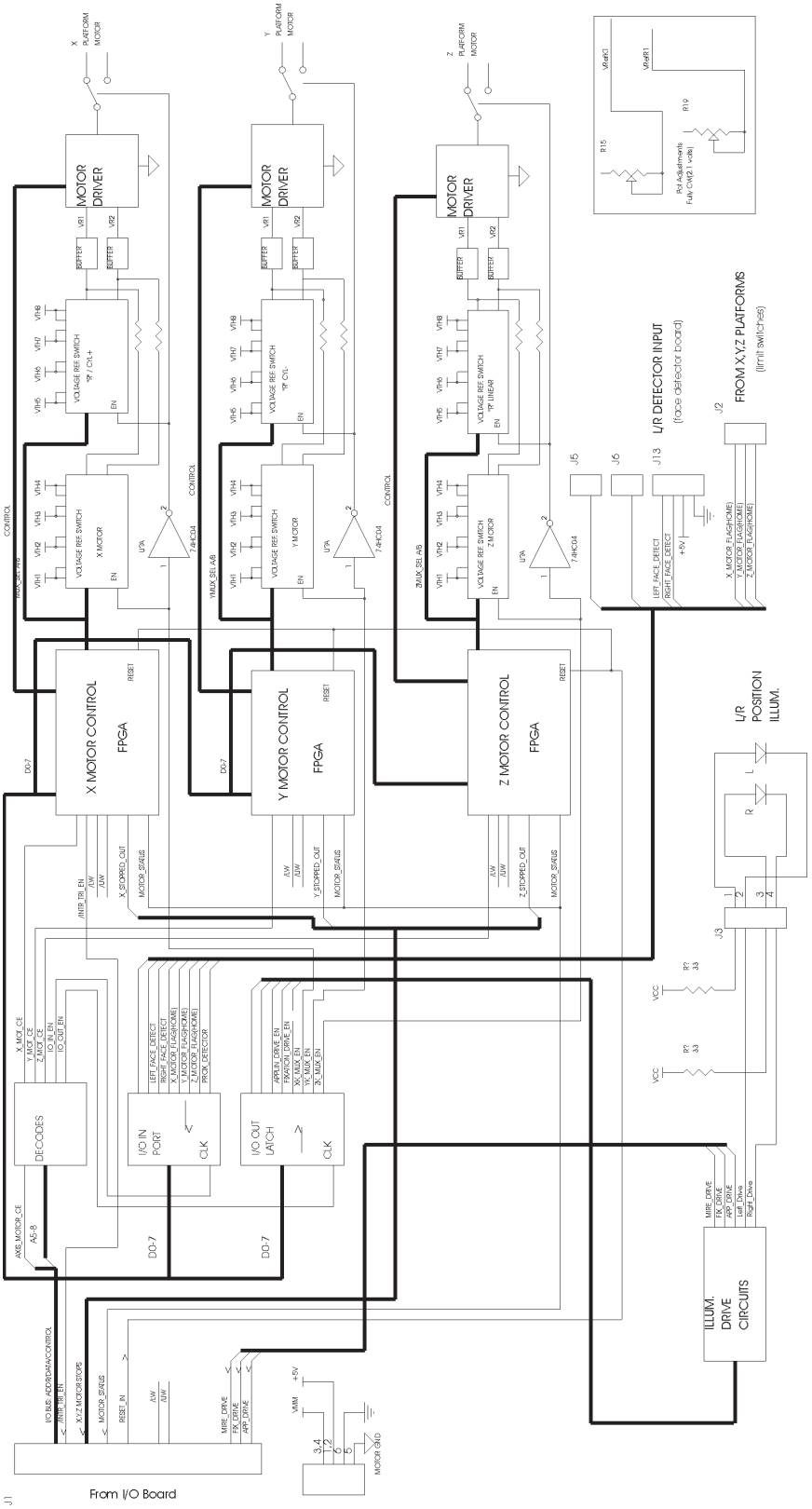

Figure TT-8, Motor Control Block Diagram

Calibration

Special Tools and Equipment

Note: Before performing any calibration of this instrument, it is recommended that you read and fully understand the information provided in this manual.

The following tools and fixtures are required for performance of the calibration procedures contained in this document.

- Rubber Eyes (t-bar P/N 13717, kit P/N 13702 (contains T-bar P/N 13717)). These test eyes are available as a t-bar assembly or as part of a calibration kit.

CAUTION: USE ONLY A 13717 CALIBRATED RUBBER EYE FIXTURE WHICH HAS BEEN VERIFIED FOR ACCURACY AT THE REICHERT FACTORY WITHIN THE LAST 6 MONTHS OR INCORRECT CALIBRATION MAY RESULT.

- Rubber eye stand (P/N 13718 also part of 13702 kit). This stand is a support for the t-bar and positions the t-bar to the correct height and angle.
- Glass Eye (P/N 12430-800B, also part of 13702 kit). The glass eye is used to set the alignment of the VVL cameras for positioning of the measurement system.
- Service Software Card (P/N 13900-953, 13900-954). This software provides the operating protocol when performing the calibration tests.

Note: There are two different software cards which are used for the AT550. The 1.00 revision (P/N 13900-953) includes the calibration program which is only used on the AT550 with version 1.00 and 1.01 operating software. The 1.17 revision (P/N 13900-954) includes the calibration program which is only used on the AT550 with versions 1.02 and greater of operating software.

Procedure

This AT550 is an instrument which measures inter-ocular pressure (IOP). If calibration of this instrument is required, it is recommended that only personnel which were trained by Reichert Ophthalmic Instruments perform this calibration procedure.

Please follow this procedure in the order given, unless otherwise instructed for calibration of the AT550.

CAUTION: THIS INSTRUMENT HAS ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) WHICH ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE CORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

1. Place the instrument in an area that has ESDS protection and observe the appropriate precautions.
2. Apply the correct input power to the unit as shown on the data plate of the unit. When instructed, press any button to continue. Refer to Figure CT-10 for an example of the Data Plate.
3. Press the button below the MODE icon. Then press the button below the SERVICE icon to access the calibration information. Record the software version, calibration date, and the total number of measurements.
4. Remove the input power to the AT550.
5. Open the printer door by pushing on it above the printout opening. Install the correct version of the Service Software into the PCMIA slot. Refer to the Special Tools & Equipment section for details of the correct Service Software PCMIA card. Align the printer paper in the door slot and close the Printer Door.
6. Refer to the General Disassembly section of this procedure and remove the side and top covers.
7. Apply the correct input power to the unit as shown on the data plate of the unit. When instructed, press any button to continue.
8. Press the button below the MODE icon. Then press the button below the SERVICE icon to access the Services Menu.

Pressure Delivery (Ramp) Calibration:

This test provides instructions for measurement of the air puff solenoid drive current.

1. While in the Services Menu screen, press the button beneath the DOWN ARROW icon until "CAL./VER." is highlighted. Press the button beneath the SELECT icon.
2. Press the button beneath the DOWN ARROW icon until "SOLENOID" is highlighted. Press the button beneath the SELECT icon.
3. After the unit puffs, a graphical representation of the pressure ramp will appear on the screen. The graph line must pass through the "alignment dots" on the screen. Refer to Figure CT-1.

   If the applanation curve does not pass through the "dots", remove the Tonometer Head Cover and adjust the potentiometer which is labeled "SOLENOID CURRENT ADJUST" on the tonometer circuit board until the curve passes through the "alignment dots" on the screen. To generate a new curve, press the button below the DEMO icon. Refer to Figure CT-2. Repeat as required.
4. Press the button beneath the "RETURN" icon.

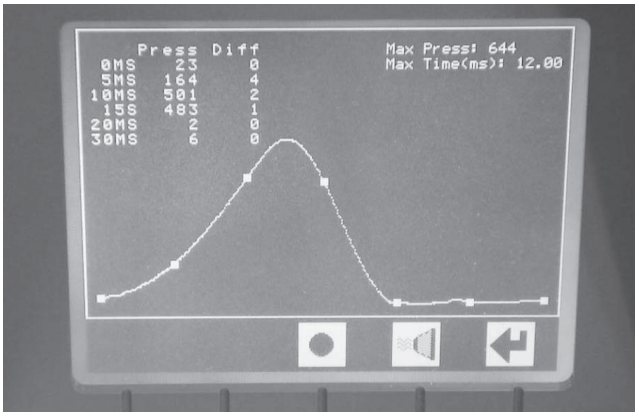

Figure CT-1. Pressure -vs-Time Waveform

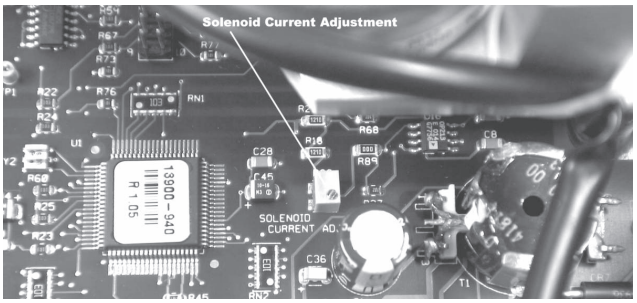

Figure CT-2. Solenoid Current Adjustment Potentiometer

Fixation Alignment

This test provides instruction regarding the alignment of the fixation spot which the patient observes during measurement.

View the green fixation spot through the air tube. Refer to Figure CT-3 for an illustration of the fixation spot. This green spot should appear centered and near the back of the tube. If the green spot is not round or has a reflection around the perimeter of the spot, the position of the circuit board must be adjusted.

To adjust the position of the circuit board, perform the following:

1. If the Tonometer Head Cover was not removed, you must remove the cover to perform the steps below.
2. Loosen the 2 screws that secure the fixation PCB assembly to the nosepiece assembly.
3. Look through the airtube assembly and tighten the circuit board when the green spot is round, centered and does not have a reflection. Refer to Figure CT-4.

NOTE: If the green fixation spot cannot be adjusted so that the spot is round and has no reflections, remove the circuit board from the tube housing and slightly adjust the position of the diode torwards the direction of the shadow.

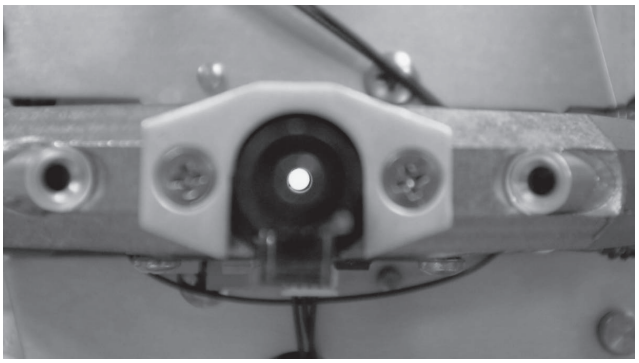

Figure CT-3. Fixation Spot

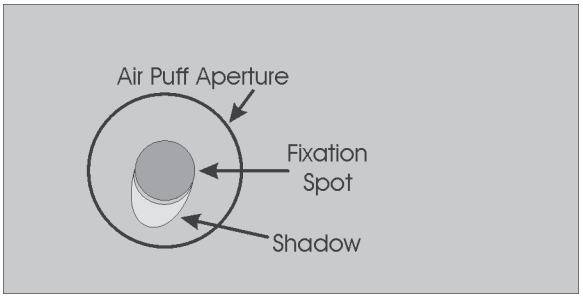

Figure CT-4. Fixation Spot Shadow

Optical Alignment

This test displays the optical alignment of the measuring system. When the square dots, representing the VVL cameras, are within the borders of the target squares the alignment of the system is acceptable.

1. While in the Services Menu screen, press the button below the DOWN icon to highlight the VVL Align test, then press the button below the SELECT icon. The VVL alignment test screen will be active.
2. Install the Glass Eye tool into the end of the air-puff nozzle so that the brass support attached to the shaft of the tool is in the vertical position. Refer to Figure CT-5.

Note: The shiny brass surfaces of the Glass Eye Tool which are facing the AT550 may require darkening to eliminate reflections.

3. The square dots must be within the target squares or improper alignment of the system will occur resulting in incorrect readings, and/or asterisk readings.

Note: If the square dots are within the target squares no further testing of the VVL Alignment is required.

4. If the square dots are not within the target squares, adjust the position of the VVL cameras until the dots are best centered and within the target squares as follows: (refer to Figure CT-6)
   a. Remove the four screws which secure the cover to the tonometer head and remove the cover.
   b. Disconnect the wire harness to the Touch Sensor Plate and remove the plate from the unit.
   c. Remove the screws that attach the Rear Mask assembly to the unit.
   d. Remove the screws that attach the metal cover to the tonometer head.
   e. Loosen the two screws on the front of the casting which are on each side of the mirror for the VVL Camera which requires adjustment.
   f. Adjust the position of the VVL (Left or Right) Camera until the square dot is within the target square. When the VVL Camera is within the target squares, tighten the two screws on each side of the mirror to secure the position of the VVL Camera. Repeat steps e. and f. for the opposite VVL Camera if required.
   g. Repeat steps d thru a in their reverse order for re-assembly of this unit and installing the hardware. Torque to approximately 7.0 lbf in (0.8 N m).

Note: Only secure the cover to the tonometer head using four screws. The four screws which are to be replaced are located only on the sides. Do not replace the screws across the top of the cover. Discard the extra screws.

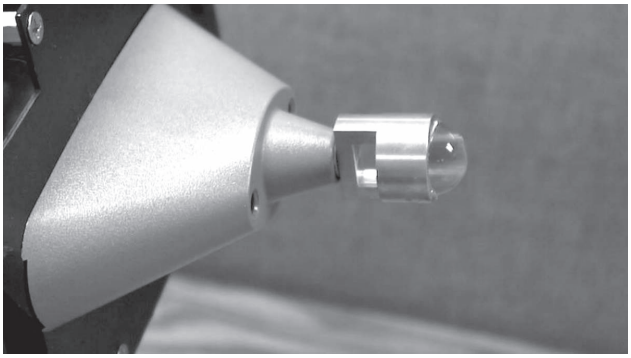

Figure CT-5. Glass Eye Fixture Installed

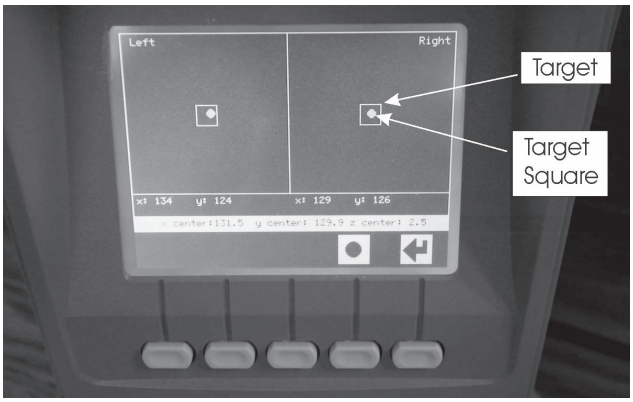

Figure CT-6. Alignment Targets and Squares

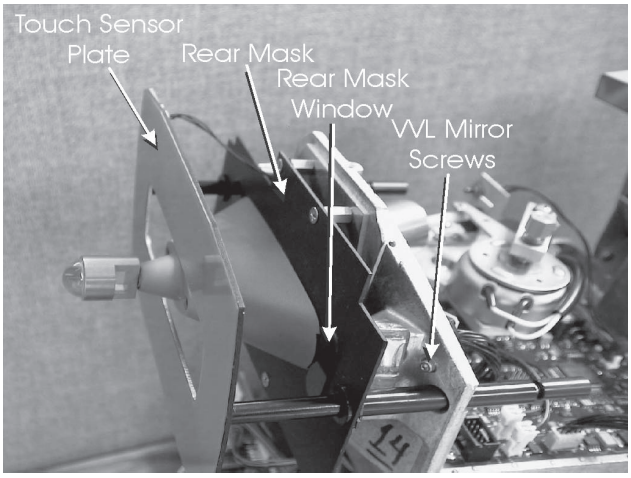

Figure CT-7. Tonometer Head Parts Identification

4. Press the button below the RETURN icon to return to the Service Menu screen.
5. Remove the Glass Eye tool from the end of the air-puff nozzle.

Fire Around

The Fire Around is a test which performs an alignment test of the optical system of the AT550. This test measures the optical alignment at the center of the test eye and then at eight equidistant points around the center of the eye. From the data (graphs) provided by this test, adjustment can be made to correct the optical alignment

1. From the Services Menu screen, press the button below the DOWN icon to highlight the Fire test, then press the button below the SELECT icon. The Fire Around Menu will be active.

CAUTION: USE ONLY A 13717 CALIBRATED RUBBER EYE FIXTURE WHICH HAS BEEN VERIFIED FOR ACCURACY AT THE REICHERT FACTORY WITHIN THE LAST 6 MONTHS OR INCORRECT CALIBRATION MAY RESULT.

2. Install your calibrated set of rubber eyes onto the rubber eye stand and align the middle rubber eye in front of the air-puff nozzle approximately 0.5 to 1.0 inches (1.3 to 2.5 cm) from the end of the nozzle. Refer to Figure CT-8.
3. Press the button below the RIGHT arrow to select the digit which requires modification. Press the button below the + icon until the value is 2.0 steps. Press the button below the MEASURE icon.
4. The AT550 will take nine measurements and then display nine graphs. Use the LEFT and RIGHT arrows and highlight the graph which is symmetrical and has the highest peak amplitude (A). Press the button below the SELECT icon to save the graph position to memory. Refer to Figure CT-9.

Note: If you chose a graph other than the center graph, press the button below the MEASURE icon to repeat the 2.0 step test.

Note: You may have asterisk readings displayed during this part of the test. This is normal when the amplitude of one of the graphs is low.

5. Press the button below the RIGHT arrow to select the digit which requires modification. Press the button below the – icon until the value is 1.0 steps. Press the button below the MEASURE icon.
6. Use the LEFT and RIGHT arrows to highlight the graph which is symmetrical and has the highest peak amplitude (A). Refer to Figure CT-9. Press the button below the SELECT icon to save the graph position to memory.

Note: If you chose a graph other than the center graph, press the button below the MEASURE icon to repeat the 1.0 step test.

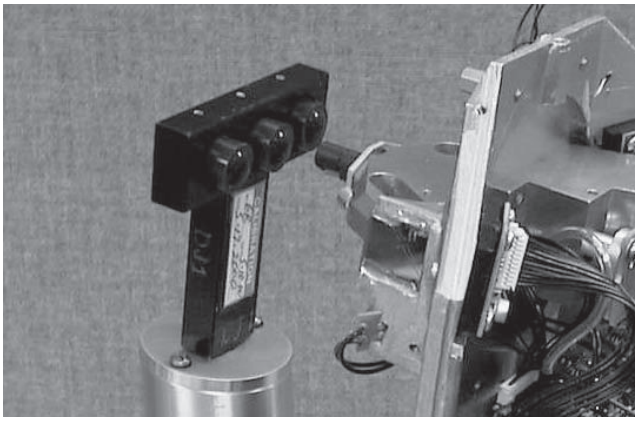

Figure CT-8. Rubber Eye Fixture

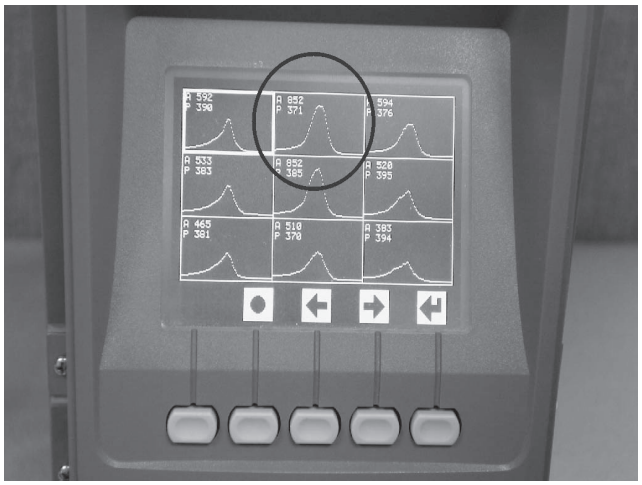

Figure CT-9. Selection of Applanation Graph

7. Press the button below the RIGHT arrow to select the digit which requires modification. Press the button below the – icon until the value is 0.8 steps. Press the button below the MEASURE icon.
8. Use the LEFT and RIGHT arrows to highlight the graph which is symmetrical and has the highest peak amplitude (A). Refer to Figure CT-9. Press the button below the SELECT icon to save the graph position to memory.

Note: If you chose a graph other than the center graph, press the button below the MEASURE icon to repeat the 0.8 step test.

Note: The peak amplitude value (A) of the center graph must be between 700 and 800. If it is not, increase or decrease the applanation gain as indicated in the Tonometer Alignment test and then perform this test again.

9. When the center graph is symmetrical and has the highest peak amplitude (A), press the button below the RETURN icon to return to the Services Menu.
10. Keep the rubber eyes in position for the next test.

Tonometer Alignment

This test displays the gain value for the applanation voltage of the measurement system. A value too high will cause saturation of the peak voltage and a value too low will cause asterisk readings.

Note: **Revision A** (shown on the data plate on the lower section of the patient's side right cover - refer to Figure CT-10) units have a potentiometer on the circuitboard inside the optical head which adjusts the applanation gain (refer to Figure CT-11). The revision A units must have the tonometer head cover removed to adjust the applanation gain.

If the gain using the control buttons on the operators side is set to any number except zero for the Revision A unit, an Error Code #5 may be displayed after removing the Service Software Card.

Revision B units contain a software gain adjustment which will adjust the applanation gain using the control buttons on the operators side while the Service Software Card is installed (the unit covers do not require removal). There is no potentiometer on the circuitboard inside the optical head for this revision.

1. Press the button below the SELECT icon while the Ton Align is highlighted. The tonometer applanation test screen will become active.
2. This screen displays the software controlled Applanation Gain Value for Revision B units (Applanation Gain Value is displayed for Revision A units, however, the value must be set to zero). This number (peak amplitude value) may be adjusted using the UP/DOWN arrows after the Optical Alignment and Fire Around tests is performed.

Note: If the Appl. Gain Value is set too high, saturation of the voltage signal may occur and cause inaccurate readings.

3. If the Appl. Gain Value was changed, press the button below the SELECT icon to save the number to memory.
4. Press the button below the RETURN icon to return to the Service Menu screen.

Figure CT-10. Revison Location

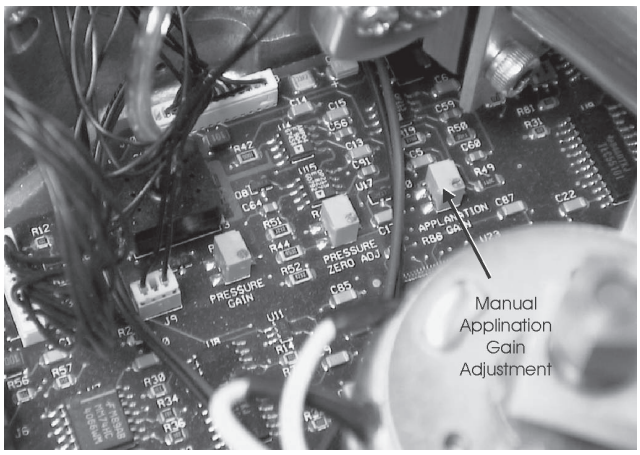

Figure CT-11. Applanation Manual Pot Location

Rubber Eye Calibration

The rubber eye calibration test sets and/or checks the IOP measurements of the instrument so that it will provide readings within the tolerances of the calibrated rubber eye fixture.

Perform the following:

Note: Before starting this test, ensure that the rubber eyes are clean and not damaged. Cleaning instructions were included with the calibrated eyes. If cleaning instructions are not available, please contact customer service as indicated in the Introduction section of this instruction sheet and one can be sent to you.

1. While in the Services Menu screen, press the button below the DOWN icon to highlight the Cal./Ver. test, then press the button below the SELECT icon. The Calibration Type Menu will be active.
2. Press the button below the DOWN icon to highlight the Eye test, then press the button below the SELECT icon. The Tonometer Calibration screen will be active.
3. Install the set of rubber eyes onto the rubber eye stand and move the low rubber eye in front of the air-puff nozzle on the AT550 approximately 0.5 to 1.0 inches (1.3 to 2.5 cm) from the end of the nozzle. Refer to Figure CT-12.
4. Using the DOWN arrow, highlight the LOW menu choice. Then press the button below the SELECT button to activate the menu choice.

Note: If your data sheet does not have a section for the AT550, your rubber eyes are out of date and will require recalibration. DO NOT use the values for the NCTII, Xpert, or the Xpert Plus.

5. Refer to the AT550 section of the data sheet which was provided with the rubber eyes and set the Tonometer Calibration number to be the same as the Rubber Eye Assigned Value. Use the RIGHT arrow to select the digit which requires modification. Press the buttons below the +/- icons to increase (+) or decrease (-) the value.
6. Press the button below the MEASURE icon. The instrument will take 5 measurements.

Note: The measurements may not match the value which was entered for that eye. After all measurements are taken for the three rubber eyes, the instrument will calculate the correct internal values after the calculate button is pressed.

7. Move the Medium Eye in front of the air-puff nozzle.
8. While in the Tonometer Calibration menu screen, press the DOWN icon button to highlight the Medium eye then press the SELECT button to modify the values for the medium eye. Use the +, –, and the RIGHT buttons to modify the values for the medium eye. When the number is the same as that which is on the Calibration Sheet, press the button below the MEASURE icon. The instrument will take 5 measurements.
9. Move the High Eye in front of the air-puff nozzle.
10. While in the Tonometer Calibration menu screen, press the DOWN icon button to highlight the High eye then press the SELECT button to modify the values for the High eye. Use the +, –, and the RIGHT buttons to modify the values for the High eye. When the number is the same as that which is on the Calibration Sheet, press the button below the MEASURE icon. The instrument will take 5 measurements.
11. After all measurements are taken, press the button below the CALCULATE icon. Refer to Figure CT-13.
12. After the instrument has completed the calculations, press the button below the RETURN icon twice to return to the Services Menu.

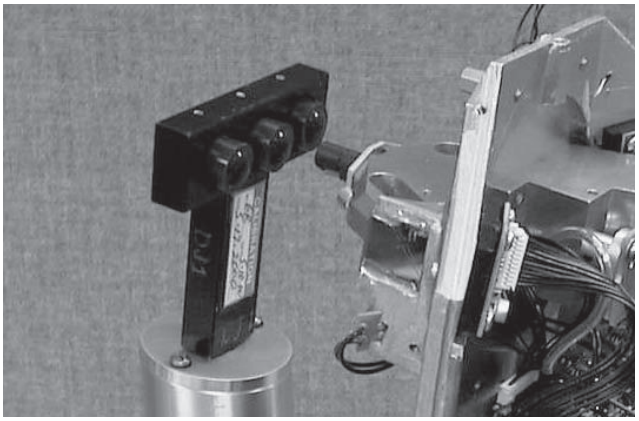

Figure CT-12. Rubber Eye Setup

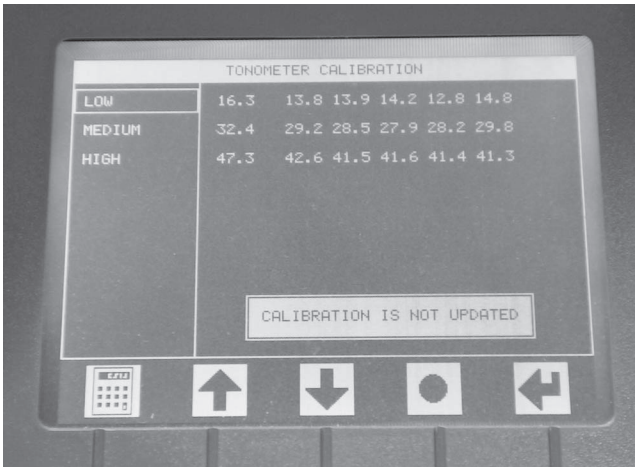

Figure CT-13. Rubber Eye Calibration Screen

Final Checks

This paragraph provides the final checks and steps to ensure that the unit is fully functional after a calibration has been performed using the Service Card.

1. Ensure that the tonometer head cover and Nosepiece Cover are installed and then perform a final Fire Around check of the low and high rubber eyes using 0.8 steps to ensure that the optical alignment is still within specifications of the calibrated rubber eyes and has an acceptable peak amplitude.
2. Ensure all input power to the AT550 is disconnected and then reinstall the side covers using the four lower screws which were removed. Torque to approximately 12.0 lbf in (1.4 N m).
3. Install the screws washers, and spacers (which were removed) to secure the top section of the side covers. Torque to approximately 10.0 lbf in (1.1 N m).
4. Attach the connector from the left/right detector to the mating connector attached to the motor board at J13.
5. Install the top cover and secure the screws (attached to the top cover) into the bracket attached to the to the side covers. Torque to approximately 12.0 lbf in (1.4 N m).

CAUTION: USE ONLY A 13717 CALIBRATED RUBBER EYE FIXTURE WHICH HAS BEEN VERIFIED FOR ACCURACY AT THE REICHERT FACTORY WITHIN THE LAST 6 MONTHS OR INCORRECT CALIBRATION MAY RESULT.

6. Align the low value calibrated rubber eye in front of the air-puff nozzle approximately 0.5 to 1.0 inches (1.3 to 2.5 cm) from the end of the nozzle (Refer to Figure CT-7).
7. Apply the correct input power to the unit and then press any button when displayed.
8. Place your hand approximately 2 inches (5 cm) from the top cover and in front of the right face detector (operator's right side) and then press the measure button. Take three readings.

Note: If the right side face detector is working, the left/right icon will not appear. If the left and right icon appear, the detector is not working, the patient was too far from the detector, or both detectors were activated.

9. After the measurement is complete, align the high value calibrated rubber eye in front of the air-puff nozzle approximately 0.5 to 1.0 inches (1.3 to 2.5 cm) from the end of the nozzle (Refer to Figure CT-7).
10. Place your hand approximately 2 inches (5 cm) from the top cover and in front of the left face detector (operator's left side) and then press the measure button. Take three readings.
11. Print the results and observe that the printer is functioning correctly and that the characters are legible.
12. Move the calibrated rubber eye away from the air-puff nozzle and press the measure button. Place your finger approximately 1 inch (2.5 cm) in front of the air-puff nozzle. The tonometer should move toward your finger without touching it and then display "Too Close."

Note: If the tonometer touches your finger with it held still, the proximity sensor may not be working correctly. If the proximity sensor is not working, please call Reichert at the number given in the Introduction section of this procedure.

13. Press the red reset button located behind the printer door and ensure that the unit restarts correctly. Press any key to continue.
14. Press the button below the MODE icon and then press the button below the LOCK icon. This will move the tonometer head into position so that the travel lock can be engaged.
15. Engage the travel lock by inserting a Phillips #2 screwdriver into the slot and pushing it forward then turn the screw clockwise until it is hand tight (approximately 4 full turns).

Note: A description with pictures of engaging the travel lock is provided in the User's Guide for your reference.

Note: This completes the final checks for the unit. The unit should be ready for packaging and/or transportation.

Note: If any of these final checks are not within the limits of what is expected or performing as expected, you may call Reichert Ophthalmic Instruments at the number indicated in the Introduction section of this manual and arrange to return the instrument for service.

Cleaning

Introduction

This section contains the cleaning procedures. Names given to parts are the same parts as referenced in the AT550 Parts Manual (P/N 13900-102).

Special Tools & Equipment

None Required

Warnings & Cautions

CAUTION: DO NOT USE SOLVENTS OR STRONG CLEANING SOLUTIONS ON ANY PART OF THIS INSTRUMENT OR DAMAGE MAY OCCUR.

CAUTION: USE OF ALCOHOL ON THE LIQUID CRYSTAL DISPLAY (LCD) MAY CAUSE DAMAGE TO THE DISPLAY.

Alignment Window Cleaning Procedure

Refer to Dissassembly and perform all the steps indicated before perform the following procedure.

CAUTION: DO NOT USE ALCOHOL, SOLVENTS OR STRONG CLEANING SOLUTIONS ON THE ALIGNMENT WINDOWS OR DAMAGE TO THE WINDOWS WILL OCCUR.

1. Refer to Figure CL-1 and locate the Rear Mask Windows and wipe the outside surfaces with a clean, long handle cotton-tip swab moistened with a mild detergent solution (1 cc of liquid dish soap to one liter of clean, filtered water (filtered below 5 microns)) to remove dirt and contaminants.
2. Remove any remaining dust or foreign particles using only clean, dry, compressed air at less than 90 psig (620 kPa) on both sides of the Rear Mask.

Air Tube Cleaning

Clean the end of the air tube (also referred to as the nosepiece) with a clean, soft, cotton cloth moistened with a mild detergent solution (1 cc of liquid dish soap to one liter of clean, filtered water (filtered below 5 microns)) to remove dirt and contaminants.

Note: Use caution when cleaning the end of the airtube as misalignment of the nosepiece cover by pressing against the airtube assembly can cause asterisk readings.

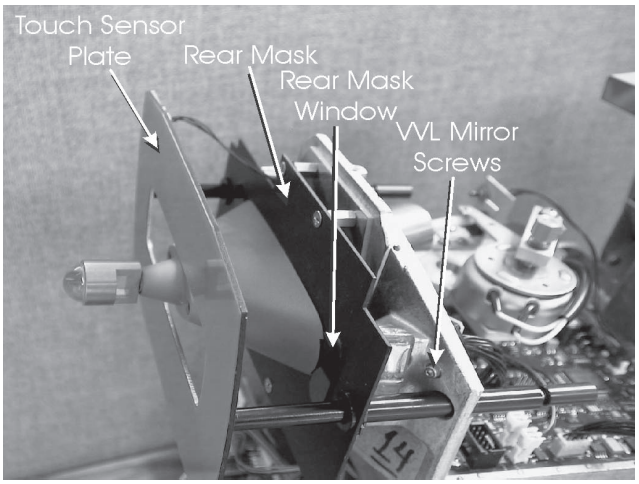

Figure CL-1. Rear Mask Windows

External Cleaning Procedure

Clean the external surfaces of this instrument using a clean, soft cloth moistened with a mild detergent solution (1 cc of liquid dish soap to one liter of clean, filtered water (filtered below 5 microns)). DO NOT USE ALCOHOL.

General Disassembly

General disassembly of the unit requires removing the outside covers and the top of the tonometer head assembly. Perform the following steps in the order given.

1. Remove the headrest assembly by pulling it straight out, away from the unit. Refer to Figure DS-1.

CAUTION: DO NOT PULL THE TOP COVER AWAY FROM THE UNIT WITHOUT DISCONNECTING THE LEFT/RIGHT DETECTOR HARNESS OR DAMAGE TO THE HARNESS OR CIRCUITS MAY OCCUR CAUSING THE LEFT/RIGHT DETECTOR TO STOP OPERATING.

2. Insert a Phillips #2 screwdriver into the access holes and turn the screws in the counterclockwise direction approximately 6 full turns. The screws only loosen and are retained inside the unit. Remove the top cover and disconnect the left/right detector harness. Refer to Figure DS-2.
3. Remove the lower screws which secure the bottom of the left and right side covers. Refer to Figure DS-3.
4. Remove the two upper screws which secure the left and right side covers. Refer to Figure DS-4.

CAUTION: DO NOT PULL THE SIDE COVER AWAY FROM THE UNIT WITHOUT DISCONNECTING THE LEFT/RIGHT DETECTOR HARNESS OR DAMAGE TO THE HARNESS OR CIRCUITS MAY OCCUR CAUSING THE LEFT/RIGHT DETECTOR TO STOP OPERATING.

5. Remove one of the screws which secure the side covers to the headrest mounting bracket. Remove both covers from the unit.

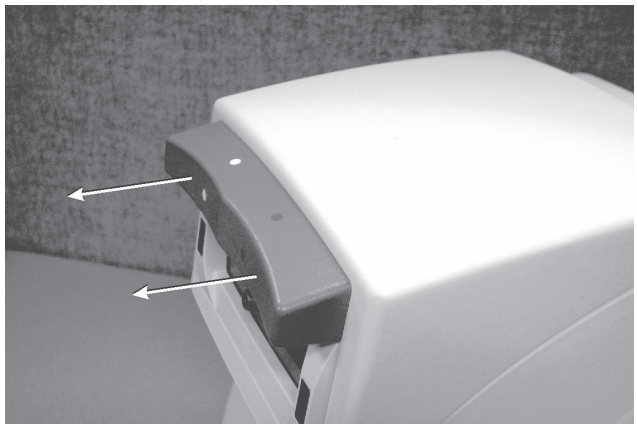

Figure DS-1. Headrest Removal

Figure DS-2. Top Cover Screws Removal

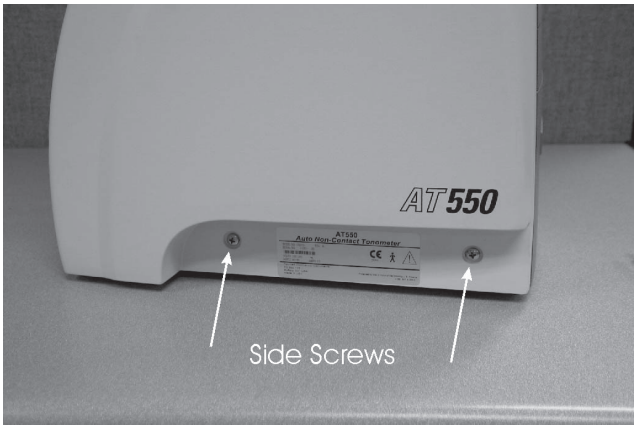

Figure DS-3. Lower Side Cover Screws

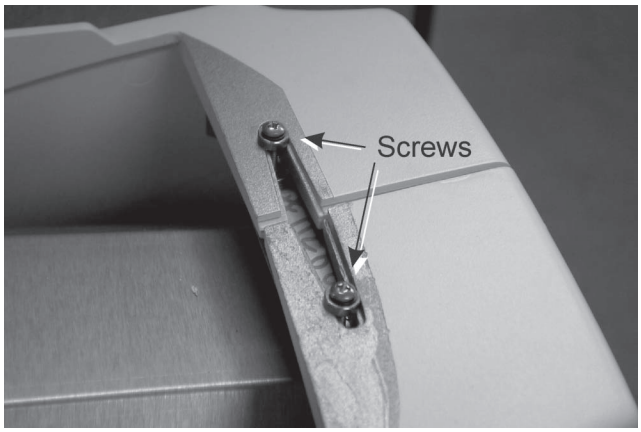

Figure DS-4. Upper Side Cover Screws

Repairs

Introduction

This section contains the repair procedures.

Names given to parts are the same parts as referenced in the AT550 Parts Manual (P/N 13900-102).

Perform all steps in Disassembly before performing any of the following repair procedures unless otherwise instructed.

After the necessary repairs are completed, perform all steps in the Assembly section of this manual unless otherwise instructed.

Special Tools & Equipment

None Required

Warnings & Cautions

CAUTION: THE INTERNAL CIRCUITS OF THIS INSTRUMENT HAVE ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) AND ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE C1`ORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

CAUTION: ANY REPAIR OR SERVICE TO THE THIS UNIT MUST BE PERFORMED BY DEALERS WHICH ARE TRAINED BY REICHERT OPHTHALMIC INSTRUMENTS SO THAT CORRECT MEASUREMENT OF THIS UNIT IS MAINTAINED.

CAUTION: THE POWER CABLE TO THE LCD DISPLAY CONTAINS VERY HIGH VOLTAGE. DISCONNECT THE INPUT POWER TO THE INSTRUMENT BEFORE DISASSEMBLY OF THE UNIT OR SERIOUS PHYSICAL INJURY MAY OCCUR IF THE HIGH VOLTAGE CONNECTIONS ARE TOUCHED WHILE THE UNIT IS OPERATING.

CAUTION: DO NOT USE SOLVENTS OR STRONG CLEANING SOLUTIONS ON ANY PART OF THIS INSTRUMENT OR DAMAGE MAY OCCUR.

List of Repairs

Repair 1	Nosepiece Cover Replacement
Repair 2	Printer Door Latch Replacement
Repair 3	Printer Replacement
Repair 4	Power I/O Circuit Board Replacement
Repair 5	Control Circuit Board Replacement
Repair 6	LCD Sdcreen Replacement
Repair 7	Motor Circuit Board Replacement

Repair 1

Nosepiece Cover Replacement

The steps below provide the information for changing the Nosepiece Cover.

1. Disengage the connection to the Touch Plate and then remove the Touch Plate from the unit.

Note: Do not loose the insulation bushings which are installed between the Touch Plate and the Spring Tubes

2. Press the top and bottom of the Nosepiece Cover together until the locking tabs release from the Rear Mask. Refer to Figure R1-1 for an illustration of the location of the Rear Mask.

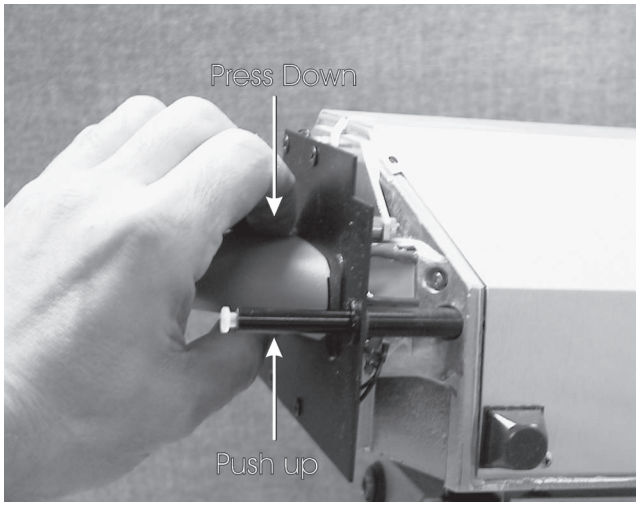

Figure R1-1. Nosepiece Cover Removal

3. Install the new Nosepiece Cover onto the Rear Mask from which the old one was removed.

Note: Make sure that the Nosepiece Cover is installed flat against the Rear Mask or it may apply pressure to the tip of the airtube and cause misalignment of the air delivery system causing asterisk readings or no applination to be displayed on the LCD.

Repair 2

Printer Door Latch Replacement

This section details the steps necessary to replace a broken printer door latch.

Note: For this repair it is not necessary to perform the steps in Disassembly or Assembly.

1. Open the printer door and pull the latch finger assembly completely out of the Latch (Fig.3,11) using a pair of pliers. Refer to Figure R3-1.
2. Put a cut in the middle of the top and bottom sides of the exposed part of the empty latch. Refer to Figure R3-2.
3. Using a needle nose plier, hold one side of the exposed part of the latch and push it toward the center and at the same time pull it out so that it releases on one side.
4. Repeat the above step for the other side of the empty latch. When the side releases, the latch should pull completely out of the unit.
5. Install a new Latch by carefully pushing it into the hole.
6. Take a small file and remove the sharp edge on the inside corner of the latch head (between the door and the end of the latch head) that mates with the new latch just installed.

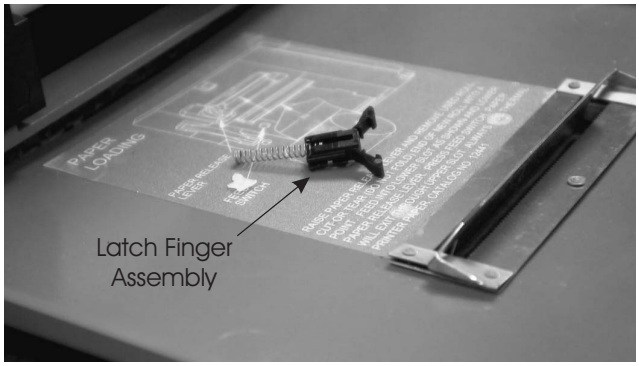

Figure R2-1, Latch Fingers

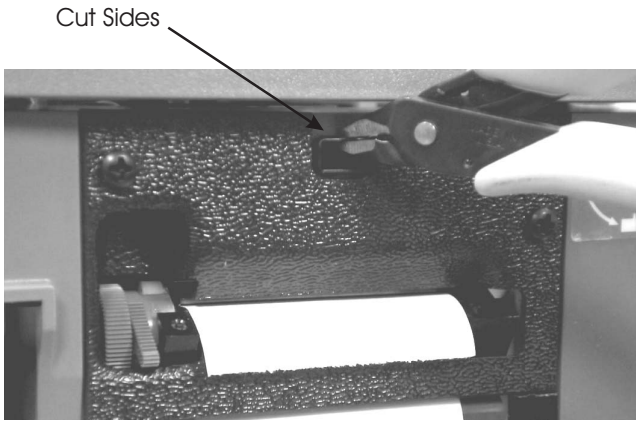

Figure R2-2, Latch Removal

Repair 3

Printer Replacement

This section details the steps necessary to replace a defective printer. It is not necessary to perform the steps in the Dissassembly section of this manual to perform this repair sequence.

CAUTION: THE INTERNAL CIRCUITS OF THIS INSTRUMENT HAVE ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) AND ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE CORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

1. Open the printer door and remove the Printer Cover Screws which secure the Printer Cover to the Printer Assembly.
2. Remove the four screws which secure the Printer Assembly to the Printer Mount.
3. Remove the four screws which secure the Printer Mount to the Bracket Assembly.
4. Detach the two harnesses from the Printer Assembly.
5. Remove the Printer Assembly from the Printer Mount.

Note: It is difficult to remove the Printer Assembly from the Printer Mount. Refer to Figures R3-2 through R3-4 for illustrations of the Printer Assembly removal.

6. Install the new printer into the Printer Mount in the reverse order that it was removed.
7. Attach the two printer harnesses to the printer.

CAUTION: DO NOT OVER TIGHTEN THE SCREWS TO THE PRINTER MOUNT AS VERY LITTLE TORQUE IS REQUIRED (4.0 - 6.0 IN LBS).

8. Secure the Printer Assembly to the Printer Mount using the four screws.
9. Set the Printer Mount against the Bracket Assembly and align the PC Card Slot into the groove at the rear of the Printer Mount. Secure the Printer Mount to the Bracket Assembly using the four screws.

CAUTION: DO NOT OVER TIGHTEN THE SCREWS WHICH SECURE THE PRINTER COVER TO THE PRINTER MOUNT AS VERY LITTLE TORQUE IS REQUIRED (4.0 - 6.0 IN LBS).

10. Secure the Printer Cover to the Printer Mount using the two screws.
11. Align the paper through the paper slot and close the printer door.

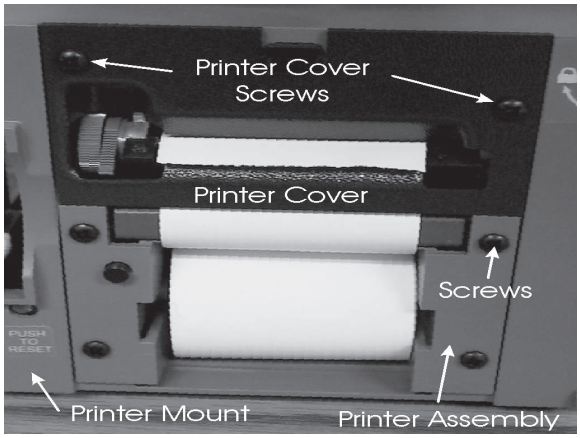

Figure R3-1, Printer Parts ID

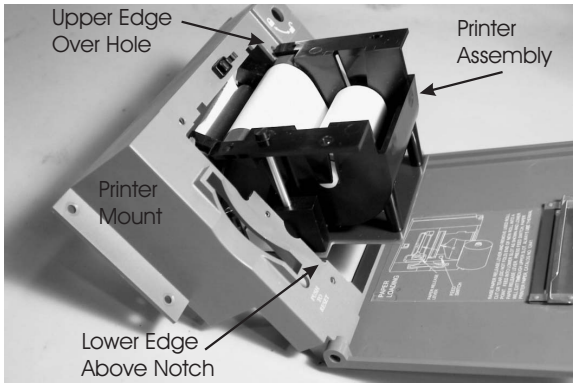

Figure R3-2, Printer Removal Step 1

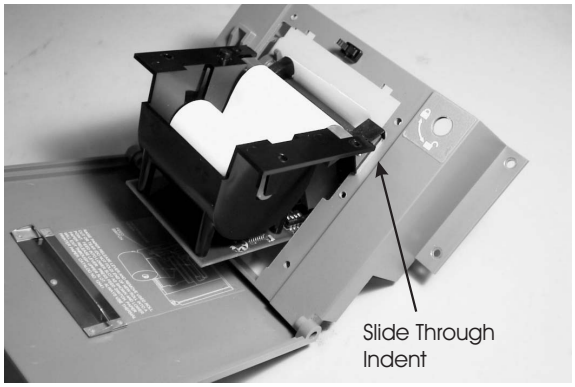

Figure R3-3, Printer Removal Step 2

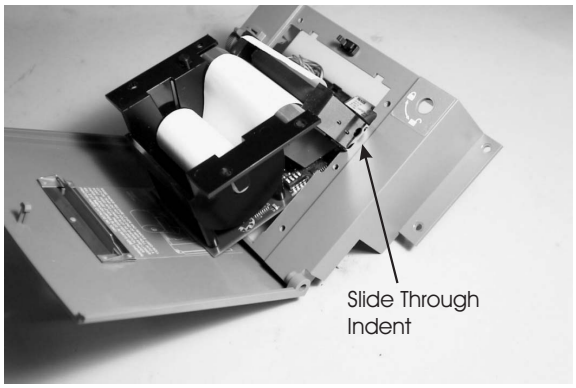

Figure R3-4, Printer Removal Step 3

Repair 4

Power I/O Circuit Board Replacement

This section details the steps necessary to remove/ replace the power I/O board.

CAUTION: THE INTERNAL CIRCUITS OF THIS INSTRUMENT HAVE ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) AND ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE CORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

Special Tools and Equipment

Dow Corning* RTV 732 Multi Purpose Sealant

Power I/O Board Removal

Refer to Figure R4-1 for the layout of the circuit board.

1. Disconnect the earth ground connection from under the Tonometer Head.
2. Disconnect the power connector (J13) at the Power I/O Board (referred to as PIOB) which connects to the Tonometer Head.
3. Disconnect the data harnesses (J11) and the power harness (J6) on the PIOB which connects to the Motor Board.

CAUTION: DO NOT TO CUT INTO THE WIRES WHICH SECURE THE WIRES TO THE XYZ POSITIONING SYSTEM.

4. Cut the plastic wire tie which secures the transformer and ground wires to the XYZ Positioning Assembly.
5. Remove the four screws, washers, and nuts which secure the XYZ Positioning Assembly to the Mounting Base. Seperate the XYZ Positioning Assembly (and Tonometer Head assembly) from the Base Casting. Set the XYZ Positioning Assembly on its side next to the Base Casting.
6. Disconnect the power connector (J3) and the data harness (J8) at the PIOB which connects to the LCD screen.
6. Disconect the power connector (J10) and the data harness (J12) at the PIOB which connects to the Printer Assembly.
7. Disconnect the power connector (J5) at the PIOB which connects to the Transformer.
8. Disconnect the data harness (J7) at the PIOB which connects tothe Keypad Assembly.
9. Remove the two stand-offs, and lock washers which secure the 9-pin computer interface connector to the Power Identification Panel.
10. Remove the three screws which secure the PIOB to the Base Casting.
11. Remove the Power I/O Board from the Base Casting.

- Continued -

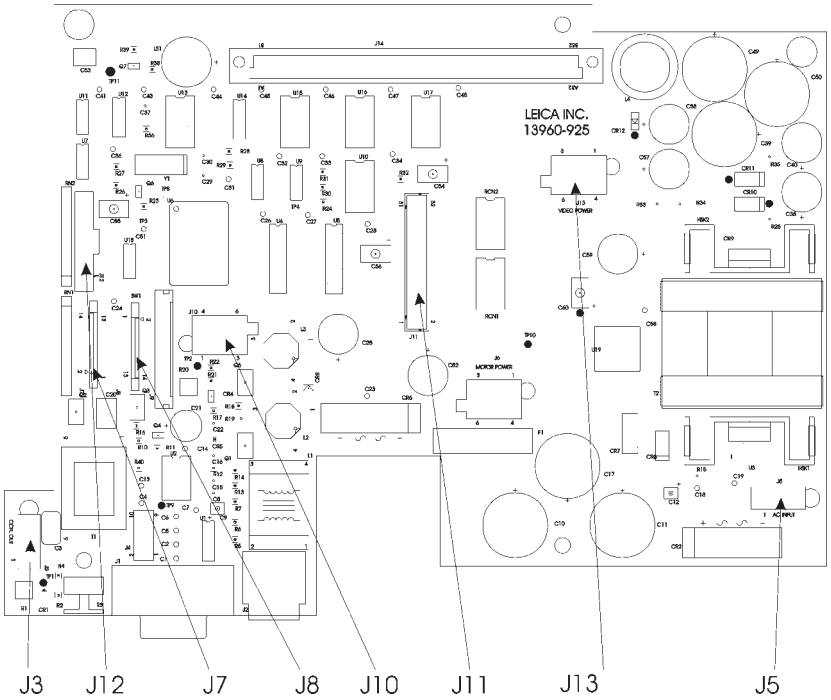

Figure R4-1, Connector Locations

* Dow Corning is a registered trademark of Dow Corning

Repair 4 (Continued)

Power I/O Board Installation

CAUTION: THE INTERNAL CIRCUITS OF THIS INSTRUMENT HAVE ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) AND ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE CORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

1. Remove the new Power I/O Board (PIOB) from its anti-static bag using ESD precautions and then set the PIOB in place onto the Base Casting and align the PIOB over the three plastic stand-offs. Secure the PIOB onto the plastic standoffs. Place the damaged PIOB into the anti-static bag.
2. Secure the PIOB with the three screws and washers.
3. Install the two stand-offs and which secure the Computer Interface connector to the Base Casting.
4. Install the data harnesses (J7, & J8) from the Keypad Assembly and LCD to the PIOB. Ensure that the locking bars of the connectors are engaged. Apply a thin bead of RTV 732 or equivalent across the top of each of the connectors to aid in securing the cables to the connector.
5. Attach the power connector (J5) from the Transformer to the PIOB.
6. Attach the data connector (J12) and the power connector (J10) from the Printer Assembly to the PIOB.
7. Attach the LCD power connector (J3) to the PIOB.
5. Place the XYZ Positioning Assembly over the Base Casting and install the four screws, washers, and nuts which secure it to the Base Casting.

Note: Ensure that the Control Board (side circuit board attached to the XYZ Positioning Assembly) is correctly placed into its slot on the Printer Mount so that when a PCMIA card is installed into the slot it does not bind.

6. Attach the data harness (J11) and the power connector (J6) from the Motor Board to the PIOB.
7. Attach tonometer power connector (J13) to the PIOB.
8. Attach the earth ground harness from the Base Casting to the terminal lug on the bottom of the Tonometer Head near the LCD.
10. Secure the earth ground wires and the transformer input power harness to the tie wrap mount on the side of the XYZ support bracket using a plastic tie wrap.
11. Perform the steps in the LCD Adjustment section of this manual so that the correct voltages are set on the PIOB for the LCD assembly.
12. Perform the steps in the Assembly section of this manual for final assembly.

Repair 5

Control Circuit Board Replacement

This section details the steps necessary to remove/ replace the Control Board.

CAUTION: THE INTERNAL CIRCUITS OF THIS INSTRUMENT HAVE ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) AND ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE CORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

Control Board Removal

1. Remove the plastic tie wrap which secures the wires to the J2 connector.
2. Remove the two screws which attach the Control Circuit Board (CCB) to the XYZ Positioning Assembly.
3. Remove the two screws which secure the Printer Mount on the CCB side of the unit. Loosen the other two screws so that the Printer Mount can move forward on the CCB side of the unit.
4. Remove the CCB from the unit.
5. Remove the stand-offs from the top side of the CCB.
6. Observing ESD precautions, remove the new CCB from its anti-static bag and install the stand-offs onto the new CCB. If the new CCB does not have a chip in the U18 socket, remove it from the damaged CCB and install it onto the new CCB.
7. Place the new CCB onto the Power I/O Board and align; the reset button into its hole, and the top of the CCB into its slot on the back side of the Printer Mount. Carefully press the CCB into its mating connector on the Power I/O Board.

Note: Before installing the screws which secure the CCB, install a PCMIA card into the slot to ensure that it does not bind. Remove it when aligned.

8. Install the two screws which secure the CCB to the XYZ support bracket.
9. Attach the data connector (J2) from the tomometer head to the CCB.
10. Secure the wires from the tonometer head to the tie wrap mount on the CCB using a plastic tie wrap.
11. Perform the steps in the Assembly section of this manual for final assembly.

Repair 6

LCD Screen Replacement

Introduction

This instruction sheet provides instructions regarding installation of a replacement LCD screen (P/Ns 13920-947, 13960-945, or 13960-966).

Special Tools & Equipment

Digital Voltmeter (-50 to +50 VDC)

Procedures

Disconnect all input power from the unit. Remove the top and side covers of the unit as indicated in the Service Manual.

CAUTION: ANY REPAIR OR SERVICE TO THE THIS UNIT MUST BE PERFORMED BY DEALERS WHICH ARE TRAINED BY REICHERT OPHTHALMIC INSTRUMENTS SO THAT CORRECT MEASUREMENT OF THIS UNIT IS MAINTAINED.

CAUTION: THE INTERNAL CIRCUITS OF THIS INSTRUMENT HAVE ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) AND ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE CORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

CAUTION: THE POWER CABLE TO THE LCD DISPLAY CONTAINS VERY HIGH VOLTAGE. DISCONNECT THE INPUT POWER TO THE INSTRUMENT BEFORE DISASSEMBLY OF THE UNIT OR SERIOUS PHYSICAL INJURY MAY OCCUR IF THE HIGH VOLTAGE CONNECTIONS ARE TOUCHED WHILE THE UNIT IS OPERATING.

Removal of the damaged LCD

Note: Ensure all input power to the unit is disconnected before removal of the LCD.

1. Remove the four screws which attach the front bezel with the Reichert logo. Remove the bezel.
2. Remove the four screws which secure the LCD to its mounting bracket.
3. Disconnect the LCD data connector which attaches onto the back side of the LCD at connector CN1.
4. Disconnect the high voltage LCD backlight connector which attaches to the bottom circuit board at J3.

Installation of the New LCD

1. Attach the data cable to the back of the LCD at CN1. Ensure that the cable is secure and oriented straight into CN1.
2. Install the new LCD screen using the four screws which were removed. Use one drop of threadlocker (e.g. Loctite 222**) on the threads to secure the screws.
3. Attach the High Voltage LCD backlight connector to the J3 connector on the bottom circuit board. Ensure that the cable is routed through the tie wrap located around the front support and that the connector is locked into position.
4. Install the front bezel using the four screws which were removed. Use one drop of threadlocker (e.g. Loctite 222) on the threads to secure the screws.

Note: Do not install the outside covers at this time.

5. Refer to the Testing section of this manual and perform the steps in the LCD Brightness Adjustment paragraph.
6. Refer to the Testing section of this manual and perform the steps in the LCD Contrast Adjustment paragraph.
7. Perform the Steps in the Assembly section of this manual for final assembly.

** Loctite is a Trade Name of Loctite CORP., U.S.A.

Repair 7

Motor Board Replacement

This section details the steps necessary to remove/ replace the Motor Board.

CAUTION: THE INTERNAL CIRCUITS OF THIS INSTRUMENT HAVE ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS) AND ARE SENSITIVE TO STATIC HIGH VOLTAGES STORED IN AND TRANSFERRED BY THE HUMAN BODY. OBSERVE CORRECT ESDS PRECAUTIONS OR PREMATURE MALFUNCTION OF THIS INSTRUMENT WILL OCCUR.

Control Board Removal

1. Install identification tags to the connectors which attach to the Motor Circuit Board (MCB) as the connectors across the top of the MCB have the same colors and will phisically interchange, but will show error codes if power is applied to the unit and the connectors are not correctly attached.
2. Remove the four screws, which attach the MCB to the XYZ support bracket.
3. Remove the plastic tie-wrap which secures the wires from the XYZ Assembly to the J4 connector on the MCB.
4. Observe ESD precautions and remove the new MCB from its anti-static bag. Disconnect one connector from the damaged MCB and install it onto the new MCB. Repeat this step until all connectors are installed onto the new MCB.
5. If the new MCB does not have a chips in its XU5, XU6, and XU7 sockets, remove them from the damaged CCB and install them onto the new CCB. Place the damaged MCB into the anti-static bag.
6. Secure the new MCB onto the XYZ support bracket using the four screws which were removed.
7. Ensure that potentiometers, R15 and R19, are set fully clockwise (10:00, 4:00 position) on the MCB.
8. Attach a plastic tie-wrap to secure the sensor wires of the XYZ Assembly to the J4 connector on the MCB.
9. Perform the steps in the Assembly section of this manual for final assembly.

General Assembly

General assembly of the unit requires assembling the outside covers and the top of the tonometer head to the unit. Perform the following steps in the order given.

1. Install one of the side covers and secure it with the bottom side screws. Refer to Figure AS-1.
2. Install the other side cover and secure it with the bottom side screws. Refer to Figure AS-1.
3. Install the upper side cover screws on the operator's side of the unit and secure both side covers. Refer to Figure AS-2.
4. Tighten the top screws on the patient's end to secure the bracket to the side covers.
5. Attach the Left/Right detector harness to its mating connector and slide the wires into its retaining clip located on the side cover.

CAUTION: DURING ASSEMBLY, ENSURE THAT THE LEFT/ RIGHT DETECTOR HARNESS IS INSTALLED INTO THE HARNESS CLIP AND THAT THE UNUSED LENGTH OF WIRE DOES NOT EXTEND IN FRONT OF THE ALIGNMENT WINDOWS ON THE REAR MASK OR THE UNIT MAY LOOK FOR AND NOT FIND THE EYE DURING A MEASUREMENT.

6. Install the top cover onto the instrument so that the lower front edge of the top cover is even with the lower edge of the opening on the patient's end of the side covers. Refer to Figure AS-3
7. Insert a Phillips #2 screwdriver into the access holes and turn the screws clockwise to 10.0 lbf in (1.1 N m) secure the top cover to the unit. Refer to Figure AS-4.
8. Push the the headrest evenly onto the mounting posts. Refer to Figure AS-5.

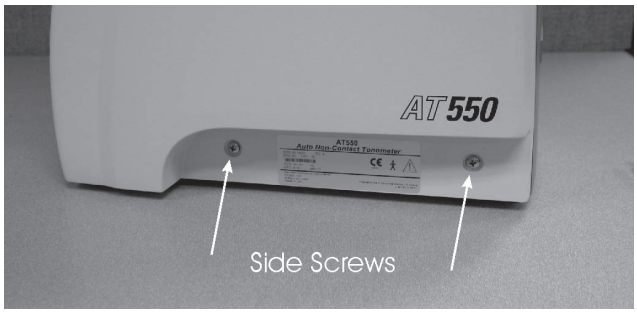

Figure AS-1. Lower Side Cover Screws

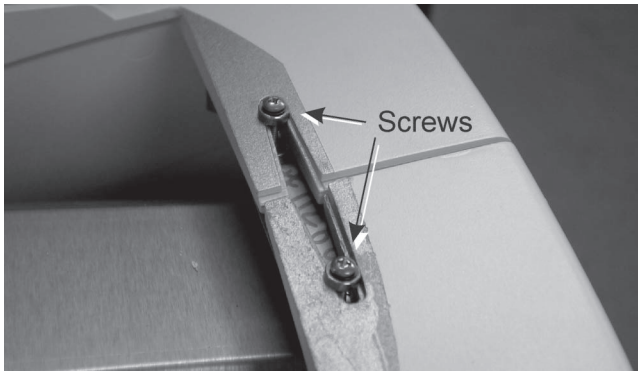

Figure AS-2. Upper Side Cover Screws

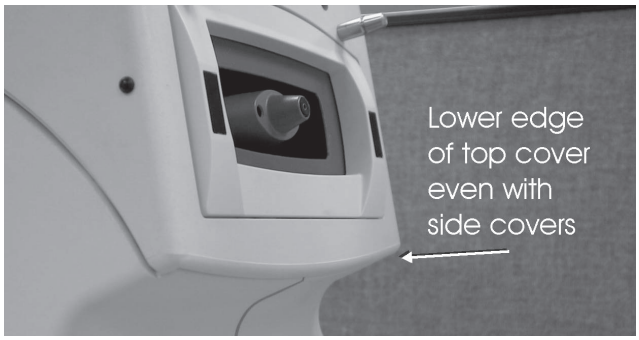

Figure AS-3. Top Cover Alignment

Figure AS-4. Top Cover Screws Installation

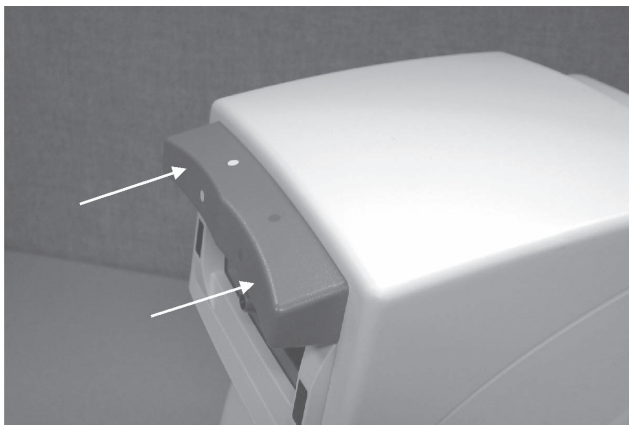

Figure AS-5. Headrest Installation

Appendix A - General Specifications

Specifications:

Height:	17 in., 43.0 cm.
Width:	9 1/2 in., 24.0 cm.
Depth:	13 1/2 in., 34.0 cm.
Weight, unpacked:	30 lbs., 13.6 kg.
Voltage:	Catalog No. 13900 100V/120V Catalog No. 13901 220V/240V
Current:	Model 13900 - 1.0 amp Model 13901 - 0.5 amp
Frequency:	50/60 Hz
Measurement Range:	0 - 60 mmHg

Transportation & Storage

This instrument can withstand the following conditions while packed for transportation or storage:

- an ambient temperature range of -40°C to + 70°C;
- a relative humidity range of 10% to 90%;
- an atmospheric pressure range of 500 kPa to 1060 kPa.

Exposure to these extremeconditions indicated above should not exceed 15 weeks.

Disposal

This product does no generate any environmentally hazardous residues. At end of product life, follow local laws and ordinances regarding proper disposal of equipment.

This product does no generate any environmentally hazardous residues. At end of product life, follow local laws and ordinances regarding proper disposal of equipment.

Appendix B - Harness Connection List

FROM	TO	DESCRIPTION	PART NUMBER
13900-921, MAIN CONTROL PCB			
13900-921, J2	13900-941, J1	MAIN VIDEO HARNESS	13900-935
13960-924, MOTOR CONTROL PCB			
13960-924, J13	13900-924, J1	L/R DETECTOR HARNESS	13900-939 / -944 ASSYs
13960-924, J2	13960-938	HOME SWITCH ASSY HARNESS	13960-938 ASSY
13960-924, J8, J10, J12	13920-948, MOTOR X MOTOR Y MOTOR Z	MOTOR ASSY HARNESS	13920-948 ASSY
13960-925, POWER I/O PCB			
13960-925, J10	13930-932, J1	PRINTER POWER HARNESS	13930-932
13960-925, J11	13960-924, J1	MOTOR DATA HARNESS	13960-940
13960-925, J12	13963-921, J2	PRINTER DATA HARNESS	13930-931
13960-925, J13	13900-922, J6	TONOMETER BOARD POWER HARNESS	13960-946
13960-925, J3	13960-966, CN2	LCD DISPLAY ASSY	13960-966 ASSY
13960-925, J6	13960-924, J4	MOTOR POWER HARNESS	13960-939
13960-925, J7	13920-924, J1	KEYPAD HARNESS	13920-939
13960-925, J8	13960-966, CN1	FLAT FILM CABLE	13920-939
INPUT POWER CONNECTIONS			
TRANSFORMER	13960-925, J5	TRANSFORMER HARNESS (115V)	13960-942
TRANSFORMER	13960-925, J5	TRANSFORMER HARNESS (230V)	13960-943
PWR. INPUT RECPT.	CHASSIS	GROUND HARNESS	13920-940
OPTICAL HEAD	CHASSIS	GROUND STRAP HARNESS	13960-951
OPTICAL HEAD ASSEMBLY			
13900-922, J1	13900-921, J2	MAIN VIDEO HARNESS	13922-935
13900-922, J2	13900-858	PISTON SOLENOID ASSEMBLY	13900-858
13900-922, J3	13960-925, J13	TONOMETER BOARD POWER HARNESS	13960-946
13900-922, J4	13900-932	POSITION CAMERA HARNESS (LEFT)	13960-947
13900-922, J5	13900-932	POSITION CAMERA HARNESS (RIGHT)	13960-947
13900-922, J6	13900-928	POSITION ILLUMINATOR (LEFT)	13900-928
13900-922, J7	13900-928	POSITION ILLUMINATOR (RIGHT)	13900-928
13900-922, J9	13900-925	FIXATION ILLUMINATOR	13900-937
13900-922, J10	13-00-927 13900-931 13900-926 13900-930	APPLANATION DETECTOR PROXIMITY DETECTOR APPLANATION EMITTER TOUCH SENSOR	13900-938
13900-922, J13	13900-943	TRAVEL LIMIT SWITCH	13900-943

Appendix C - Software Revision List

Revision 1.00 to 1.01 (12/99)

Correction of VVL camera time out during initial synchronization.
Position correction of XYZ assembly before park routine is invoked.
Y2k format change to display the correct year on the print-out.
Year format correction for the years 2000 through 2009 for printer output.

Revision 1.01 to 1.02 (2/00)

Correction of standard deviation calculation.
Protocol change to add histogram requirements.
Revision of the calibration curve (linear to quadratic curve).
Year format correction for the years 2000 through 2009 for calibration date.

Revision 1.02 to 1.10 (4/00)

Added a printer character set for service software.
Add a function to clear the shot count and clear history data with service software.
Added a function to set the digital pot in the applanation gain circuit.
Reset printer off-line at boot-up.

Revision 1.10 to 1.12 (8/00)

Added software delays to the VVL Cameras.
Decreased XYZ positioning system speed and overshoot.
Added button push to test XYZ assembly during assembly.
Added button push to test printer assembly during assembly.
Changed logo/name in software to Reichert on most units.
Added option to display kPa (mmHg was the only option).

Revision 1.12 to 1.13 (8/00)

Added RS232 port command to transfer tonometer board EPROM data to a replacement ckt. Board.
Added RS232 port command to test L/R detector (beeper).
Removed 1.12 version delay in VVL cameras.

Revision 1.13 to 1.14 (9/00)

Added 5 button push for burn-in function.
Added year correction (date) to service software.
Service software changes (cal default values, cal type printout).

Revision 1.14 to 1.15 (12/00)

Corrected intermittent operation of paper feed after boot-up.

Revision 1.15 to 1.16 (5/01)

Correct lock-up condition of motors.
Added button push for positioning when a travel lock when a touch or proximity error occurs.
Update service address for German service shop.
Added moving to travel lock position when error code occurs at boot-up.

Revision 1.16 to 1.17 (2/02)

Add changes to allow testing with the TCT fixture.
Add PTEST routine to test the XYZ position sensors and motors with test software.
Add DISPLAYTEST routine to test the LCD screen during assembly.
Correct German language screens.
Remove LOADDEF command from the service software which entered default EPROM data.
Add a software reset to the burn-in sequence to check for errors.
Add button sequence for power up during travel lock error and bad LCD screen conditions.
Add a non-clearing shot counter.
Revise the L/R beeper test.
Add OEM NCT-800 product into software.
Modify homing timeout period when XYZ cannot go home.

Ordering Information - Accessories

Catalog	***Description***
12418	Instrument stand adapter mount
12430-273	Cleaning Cloth
12441	Printer paper
13916	External power supply universal input, 16 VDC out @ 0.0 to 3.12 amps Note: This power supply is medically approved to UL2601-1, IEC60601-1 and CSA C22.2 NO. 601.1 standards
13920-084	Dust Cover
13900-101	User's Guide

To order any of these accessories, contact your local authorized Reichert dealer.

Other Reichert Products

To complement your KR460 Automated Keratometer/Refractor, we invite you to take a look at the other products made by our company:

Keratometer
LENSCHEK™ Advanced Logic Lensometer®
LongLife™ Project-O-Chart
Phoroptor® Refracting Instrument
XCEL® Slit Lamps
AT550 Auto Non-Contact Tonometer
AP250 Auto Projector

To order any of these products, contact your local authorized Reichert dealer.

Reichert Ophthalmic Instruments
A Leica Microsystems Company
PO Box 123
Buffalo, New York USA 14240-0123
Telephone: 716-686-4500
Fax: 716-686-4545
www.reichert.com
e-mail: info@reichert.com

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